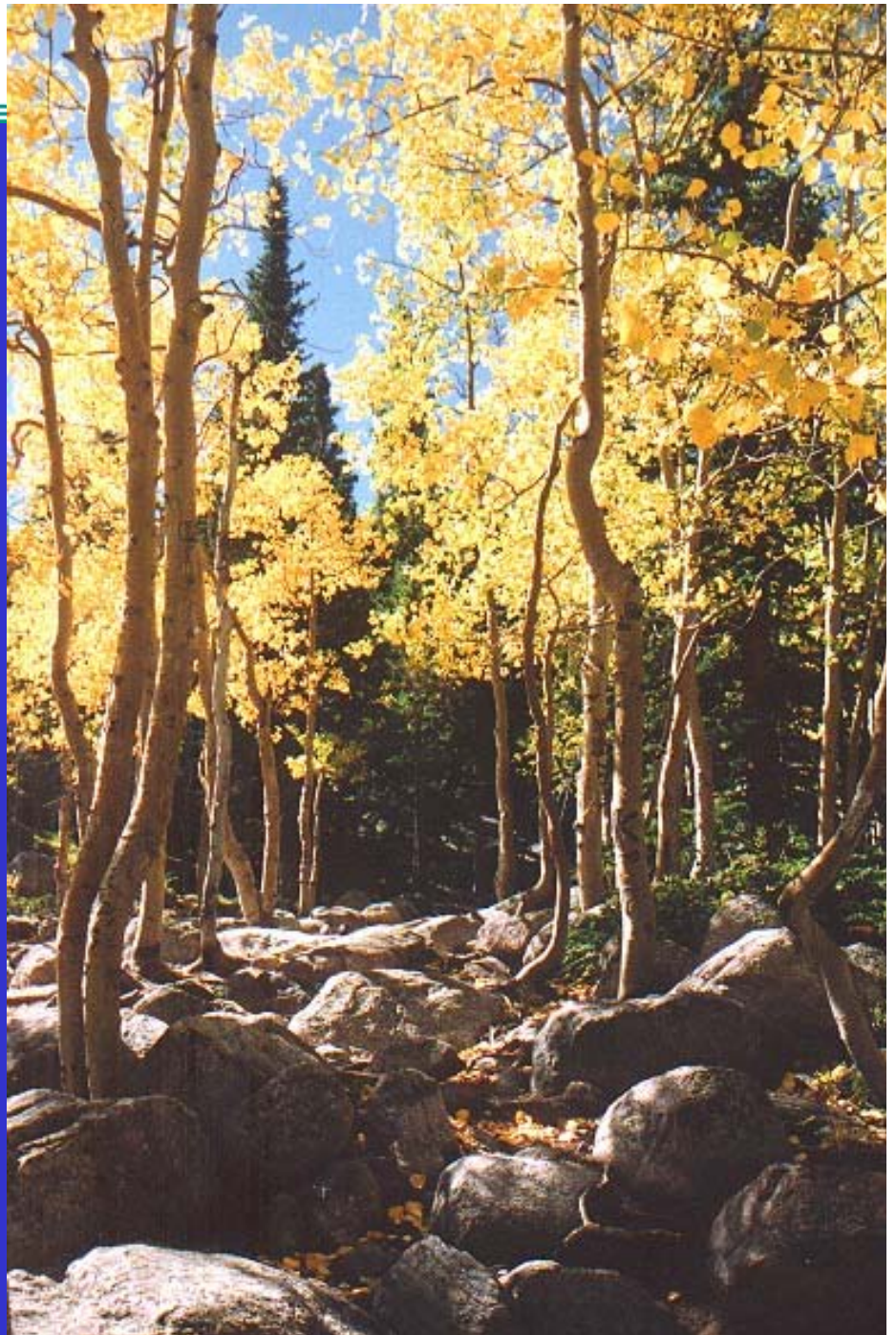


National Cooperative Soil Survey Conference Proceedings

Fort Collins,
Colorado
June 25-29, 2001



***Building for the Future:
Science, New Technology & People***



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General Session

Status of the National Cooperative Soil Survey: A Federal Perspective,¹ by Horace Smith, Director, Soil Survey Division

USDA, Natural Resources Conservation Service
Washington, D.C.

I want to thank former State Conservationist, Steve Black, and State Soil Scientist/MLRA Office Leader, Cameron Loerch, from the Natural Resources Conservation Service (NRCS); Lee Sommers, Gene Kelly, and others from Colorado State University; Pete Biggam from the National Park Service; and several individuals from the U.S. Forest Service for hosting this conference. I want to thank Maxine Levin from my staff for putting the agenda together and for providing overall coordination. A great deal of work goes into putting on a meeting of this magnitude. This conference convenes every other year on the odd-numbered year and provides an excellent forum for cooperators and other interested participants to reflect on the status of the National Cooperative Soil Survey (NCSS) and plan for the future. I think the theme of the conference is appropriate and timely: "Building for the Future: Science, New Technology and People." The agenda looks good and is structured around this theme. The four committees that will be meeting and reporting were structured to emphasize this theme.

As the permanent chairman of this conference, I want to join with the previous speakers in welcoming each of you. I offer a special welcome to our friends from abroad--Australia, Lithuania and Thailand--and would encourage them to participate fully in all aspects of this conference. I am somewhat disappointed that, so far, I don't see a large number of Experiment Station Cooperators in the audience. I hope as the week progresses, their numbers will increase. This is prime vacation season and also, there are a number of other important meetings going on this week. In order for this conference to remain strong and viable, we need the strong support and participation of all cooperators.

I became Director of the NRCS Soil Survey Division and leader of the Federal part of the NCSS in November 1996--nearly 6 years ago. Shortly after assuming these duties, I outlined several short- and long-term initiatives that I wanted to tackle. With the remaining time allotted to me, I would like to provide a brief report, from a Federal perspective, on the status of some of these initiatives.

NCSS Advisory Group

During 1997, I assembled a small group, representing all cooperators, to advise the NCSS on key actions and priorities that would lead us into the 21st century. Over the following 3 years that group met several times and came up with many excellent recommendations that have been incorporated into the Soil Survey Division Program Plan. This document has been distributed to NCSS cooperators. One key recommendation from this group

¹ Presented at the National Cooperative Soil Survey Conference, June 25, 2001, Fort Collins, Colorado.

was that more emphasis needed to be placed on strengthening the domestic Soil Survey Program here in the United States.

Town Hall Meetings

The Soil Survey Division sponsored five listening sessions between December 3, 1998, and June 2, 1999. Listed chronologically, the meetings were held in Raleigh, North Carolina; Davis, California; Portland, Oregon; Springfield, Massachusetts; and Davenport, Iowa. The initial focus of these meetings was on identifying those digital layers that internal and external users considered essential to the usability of hard-copy soil surveys. The minutes of each meeting were recorded. A total of 207 participants attended the five sessions. Roughly one-half represented the Federal Government. The remaining participants were State and local representatives, conservation district employees, or private citizens.

To facilitate data capture, questionnaires were distributed to known communities of soil survey data users and meeting participants. A total of 165 surveys were returned from both meeting participants and non-participants. The surveys and the participants at the meetings indicate that the Public Land Survey (PLS) and detailed hydrography reference layers assisted soil survey users in the location and application of data. There was also strong support for accelerating the delivery of digital soil survey data and soil survey publications in multiple formats, including electronic.

Budget

It is nearly impossible to come to a meeting such as this and not say something about the budget. There really isn't much new to say. The budget for Soil Survey has remained level over the past several years. Any new initiatives or Congressional Earmarks had to be absorbed from within the existing allocations. We have tried to manage and leverage the budget in a way to be most effective in supporting key NCSS priorities. For fiscal year 2003, the NRCS has proposed a \$10 million initiative above the existing budget for the Soil Survey. This initiative would help to improve the infrastructure at the field level and provide resources for hiring additional soil scientists. Coupled with this initiative is a proposal to give NRCS the authority and resources to map all lands--not just private lands. This proposal was first surfaced by the NCSS Advisory Group in 1997 or 1998, but never moved forward until now. It has been discussed off and on at NCSS meetings and workshops for the past 4 years. If this comes about, we see it as a positive impact on the reduction in paperwork and funding agreements associated with soil survey work on Federal lands. I will keep the NCSS informed as this budget initiative and proposal move forward.

Mapping Progress

We continue to make slow but steady progress towards getting a complete once-over soil survey for the U.S. The total area of the country that is tracked in the National Soil

Information System (NASIS) is 2,313,207,929 acres. According to NASIS, the current status is as follows:

| | |
|---|----|
| ◆ Percent of total area mapped | 91 |
| ◆ Percent of private lands mapped | 96 |
| ◆ Percent of public lands mapped | 81 |
| ◆ Percent of Indian lands mapped | 77 |
| ◆ Percent of total area updated | 6 |
| ◆ Percent of total area in need of updating | 40 |

Although over 90 percent of total land area has been mapped, 40 percent or more is in immediate need of updating to satisfy the demands of users, such as conservation and environmental planners. The areas in need of updating include mostly those that were completed prior to *Soil Taxonomy* and those where the soils were described to depths less than 60 inches. We have made good progress with mapping on private lands. The bulk of the areas remaining to be mapped are mostly in Alaska and public lands west of the Mississippi River.

Digital Database

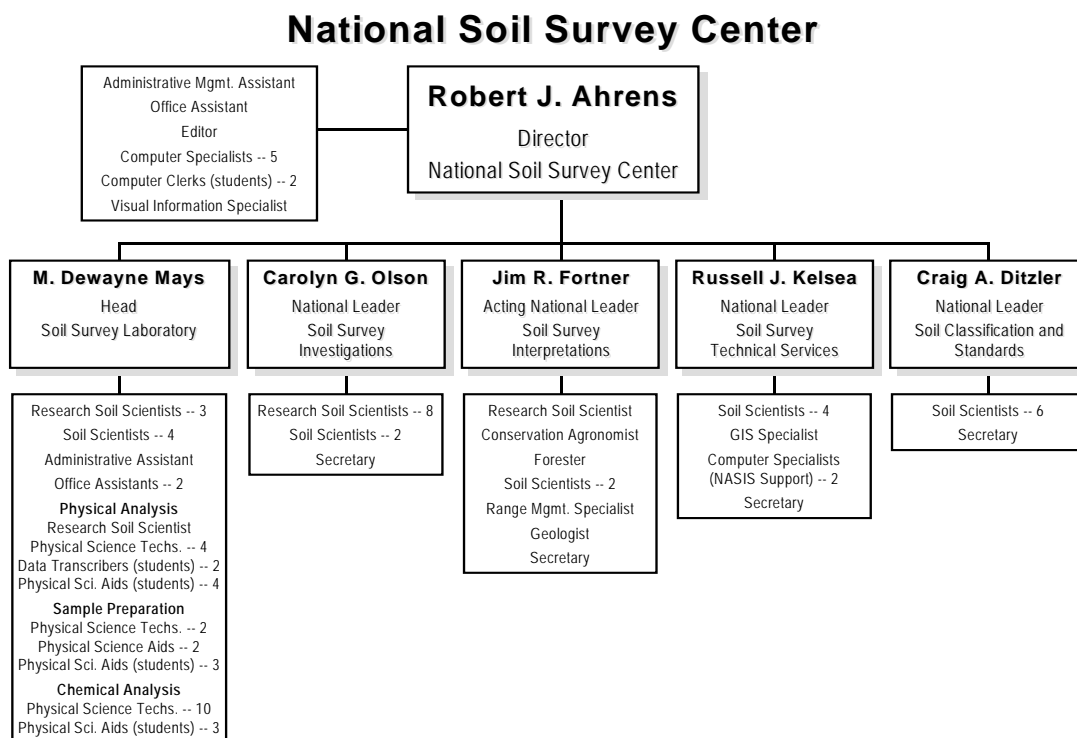
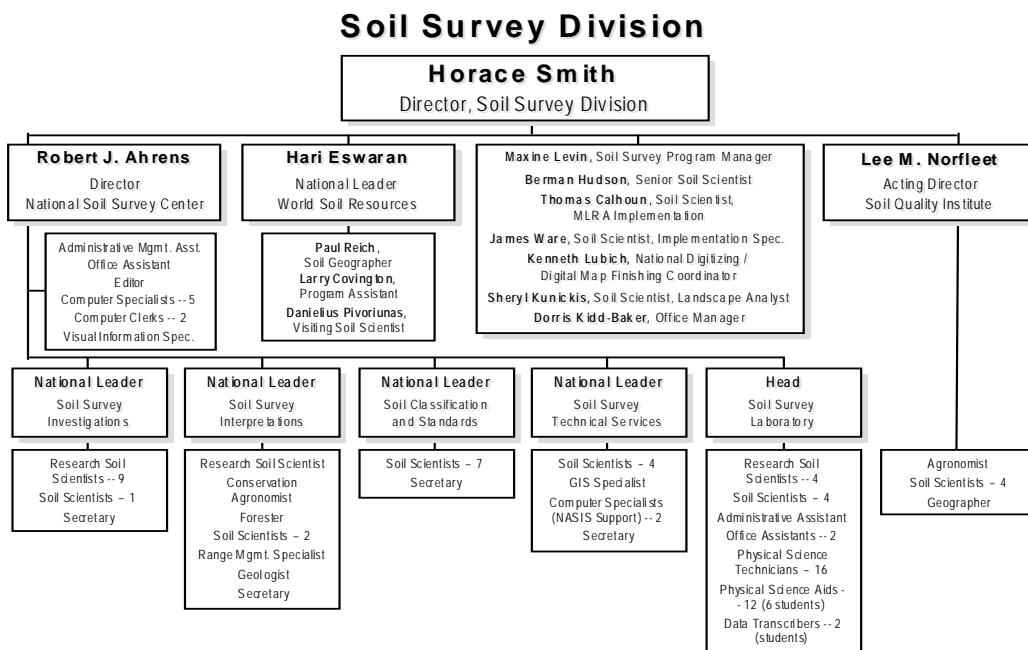
Digitized soil survey products are in high demand by soil survey users. In 1994, NRCS started earmarking funds to develop a Soil Survey Geographic Database (SSURGO). By 1995, the agency had digitized 15 soil surveys to SSURGO standards. In 1996, we established seven digitizing centers, strategically locating them around the country. I am proud to report that, as of today, we have 1,063 soil surveys digitized to SSURGO standards. This has been an extremely successful initiative and is very much appreciated by NRCS field offices and other users of soil survey information. Our goal is to continue to accelerate this initiative.

Restructuring the Soil Survey Division

In order to be more responsive to the NCSS, it was necessary to restructure the Soil Survey Division. The National Soil Survey Center and the Soil Quality Institute are now part of the Soil Survey Division. We have established three new positions on the staff in Washington, D.C. These are Senior Soil Scientist; Soil Scientist, MLRA Implementation; and Soil Scientist, Landscape Analyst. The senior soil scientist's position is the first of its kind in the agency and will assist the Director of the Soil Survey Division and the Deputy Chief for Soil Survey and Resource Assessment at the highest levels in all aspects of the Soil Survey Program. The position dealing with MLRA implementation will focus on assisting the field in transitioning to the MLRA concept. The landscape analyst position will serve as a clearinghouse for the field on new technologies related to production soil survey. It will also concentrate on assisting the field in acquiring and developing new technologies.

The National Soil Survey Center, which is the technical arm of the Soil Survey Division and is in Lincoln Nebraska, has been reorganized. The new structure has a Director and

five major functional areas. The two diagrams that follow briefly outline the restructured Soil Survey Division:



NASIS

Version 5.0 of NASIS became operational in May 2001. The biggest change for this version is the implementation of a central server. This means that all NASIS data stored at the individual MLRA Soil Survey Offices are now in a single database. All users accessing NASIS are now connected remotely to the NASIS central server at the NRCS Information Technology Center in Ft. Collins, Colorado. Initial feedback from the field and other NASIS users is very favorable concerning its overall operations.

Personnel

Our records indicate that there are about 930 NRCS soil scientists involved in the NCSS. It is estimated that about 50 to 75 non-NRCS soil scientists are involved with the NCSS in production soil survey. About one-half of the NRCS soil scientists can retire within 5 years. It is critical that the NRCS and NCSS bring on new soil scientists as soon as practical. Recently, the NRCS conducted a workforce planning exercise to take a critical look at personnel needs. This exercise revealed that unless quick action is taken, there would be very little diversity in the Soil Survey Program within the next 5 to 10 years. As a result of the workforce planning exercise, the Soil Survey Division has initiated a Soil Science Scholars Program with a few of the 1890 and Hispanic- and Native American-serving institutions. We have about 13 students in the program. The program provides limited financial support and summer internships for the scholars. Upon graduation, participants are guaranteed a position with the NRCS. The program requires that participants maintain at least a 3.0 grade point average. Joni Franklin, a scholar from Tennessee State University, is scheduled to attend this conference, but I don't believe she has arrived yet. I hope you will get a chance to meet her.

MLRA Concept

The MLRA concept, which calls for conducting project soil survey activities along natural physiographic areas rather than political boundaries, was adopted in 1995. Initially, there were 17 MLRA Offices (MOs). Due to the heavy workload and travel logistics of the Morgantown, West Virginia MO, a new MO with headquarters in Lexington, Kentucky, has been established. This new MO essentially takes over the southern one-half of the area that was once part of the Morgantown MO. As previously mentioned, a position on my staff in Washington has been established to provide national coordination for implementing the MLRA concept. I am pleased with the progress we are making with this initiative. Most parts of the country are establishing project offices that fit within the intent and spirit of the MLRA concept. Institutionalizing the MLRA concept for production soil survey at the field level is an important priority of the Soil Survey Program.

International Activities

International collaboration continues to be important to the Soil Survey Program. The budget provided by NRCS over the past 6 years for international travel in support of the Soil Survey Program has been steady. Some recent activities include:

- ◆ Participated in joint projects with Nigeria, Denmark, Ghana, Finland, and China;
- ◆ Hosted a Fulbright scholar from Lithuania for 9 months;
- ◆ Hosted two visiting scholars from Germany for extended periods of time;
- ◆ Hosted several international visitors and assisted the Foreign Agricultural Service in implementation of the Cochran Fellowship program; and
- ◆ Sponsored the participation of NRCS soil scientists in several international meetings.

Collaboration with our international partners is essential to maintaining a strong Soil Survey Program here in the U.S. Many of our standards, especially *Soil Taxonomy*, are used throughout the world, and we must continue to have them tested and refined by active international use and collaboration.

NRCS Graduate School Program

As most of you all are aware, over the years the NRCS has maintained a graduate school program that supports an employee with full salary while he or she is pursuing graduate work that is in support of the agency's mission. Several of our soil scientists who are currently in leadership positions within the Soil Survey Program are graduates of that program. The NRCS Graduate School Program for 2002 has just been announced. The program will have five slots, and three of them are reserved for the soil science discipline--soil physics, soil chemistry, and soil biology. We are hoping to receive strong applications for these three slots.

Soil Science Institute

The Soil Science Institute is an intense 4-week training session for mid-career NCSS soil scientists. The course provides a refresher in the basic and traditional soil science disciplines but also exposes the participants to new and cutting-edge technologies. The recent Institutes have been held at Texas A&M University, North Carolina State University, University of California at Davis, and Alabama A&M University. The Institute continues to be one of our most important NCSS training sessions.

Wet Soil Monitoring Project

As a continuation of some of the earlier research that was done in Texas and Louisiana during the 1980s in conjunction with the International Committee on Aquic Conditions (ICOMAQ), the Wet Soils Monitoring Project was initiated in 1991 in these participating States: Alaska, Indiana, North Dakota, Minnesota, and Oregon. New Hampshire was

added to the project in 1992. This has been a very successful project, and data from it are being used at the field level to help refine county level hydric soil lists, further develop hydric indicators, and add significantly to our soil and wetland classification knowledge base. A meeting of project personnel will be held in New Hampshire on August 13-17, 2001, to focus on synthesis and publication of findings and interpretations.

Global Climate Change

The Soil Survey Division continues to be active in the global climate change/carbon sequestration arena. During the past few years, several of our scientists have authored or co-authored important papers on this subject, organized and led seminars and meetings,

- ◆ Cooperative venture with Los Alamos National Laboratory to evaluate laser induced breakdown spectroscopy (LIBS) as potential field technique for measuring soil carbon and other elements; and
- ◆ Explore research and investigations that would lead to better interpretations and a classification scheme for anthropogenic soils.

NCSS Soil Scientist Awards

In 1999, as part of the NCSS centennial celebration, the NCSS Advisory Group recommended that two high level yearly awards be established to recognize soil scientists involved in the production phase of the Soil Survey. These two awards are: "NCSS Soil Scientist of the Year" and "NCSS Soil Scientist Achievement". These two awards were presented to the first recipients in 1999 at the NCSS Soil Survey Conference and the Soil Science Society of America Annual Meeting, respectively.

The recipient of the 2001 NCSS Soil Scientist Achievement Award is Tim Gerber, Administrator, Soil Inventory and Evaluation Section, Ohio Department of Natural Resources, Columbus, Ohio. Tim is here today, and I would ask him to stand now and be recognized. Let's give him a big hand. The award will be officially presented to Tim in October, during the Soil Science Society of America Annual Meeting in Charlotte, North Carolina. The 2001 recipient of the NCSS Soil Scientist of the Year Award is Eva Muller, NRCS Soil Survey Project Leader, Spokane, Washington. Eva is here today, and Deputy Chief Maury Mausbach and I will present this award in a few minutes at the end of my presentation.

Closing Comments

Before I take my seat, I would like to pause for a few moments and recognize two former giants of the NCSS who died recently--Drs. Al Klingebiel and Jack McClelland. I think it is appropriate that they be mentioned at this conference. Dr. Klingebiel was the first National Leader for Soil Survey Interpretations and is recognized as the father of modern soil survey interpretations. Dr. McClelland was Principal Soil Correlator for the Midwest (Corn Belt States) for many years. He later became National Leader for Soil Classification and Taxonomy and played a key role in the development of *Soil Taxonomy*.

Thank you again for coming. I'm sure we're going to have a great meeting.

Strategic Planning for the Science of Soil Survey, by Maurice J. Mausbach, Deputy Chief for Soil Survey and Resource Assessment
USDA, Natural Resources Conservation Service
Washington, D.C.

As we enter the second century of soil survey, it is good for us to take a critical look at the soil survey program as we “Build for the Future” and address the essential issues of science, new technology, and people. As you can tell, I like the theme of this conference, “Building for the Future: Science, New Technology and People”! We all need to be proud of our efforts in soil survey. Through this great partnership of the National Cooperative Soil Survey, including our international partners, we have maintained a viable soil survey program. We can attribute this to strategic thinking of our predecessors that included national standards and coordination, and the foresight of Charles Kellogg’s in assuring that soil interpretations and outreach to the user of the information (what we now call technical soil services) were an integral part of the program. Another reason for the success of soil survey is that we pursued cutting edge technology. You have truly been leaders in this effort. However, as leaders we must not become complacent. After all, if we are leading the pack and slow down, we’ll get run over!

Today, I will visit with you on some scientific considerations to ensure a healthy and viable soil survey program. I will briefly discuss staffing, soil surveys (the process and the product), the development of new tools, and technical soil services.

Staffing

The Science of soil survey first and foremost depends on highly motivated, innovative staff. We have an aging workforce, and in the next 5 years many of us will have moved on to new endeavors. It is critical that all of us, university as well as Federal partners, maintain and enhance our workforce with the brightest and best. I am gratified that many of our states are hiring soil scientists, although some of you are having trouble finding qualified candidates. I am also gratified to see that many of the universities are maintaining expertise in pedology. We need to work together with universities to let them know of our staffing needs now so that we have qualified candidates in the pipeline. We also need to use all of the tools in our hiring authorities to attract and retain new soil scientists who reflect the diversity of our society.

I have a concern about the physical well-being of our soil scientists. The field soil scientist’s job is a physical one. We must ensure the well-being of our soil scientists, who are often in the field by themselves and prone to job-related injuries. We should revisit our model of what a soil scientist does. After all, we have the word “scientist” in our title. How many scientists want to spend a considerable part of their time digging holes? We hire soil scientists to be scientists and to use their minds in developing soil-landscape models. We need to investigate ways to reduce the risk of job-related injuries and keep the field soil scientist’s job as interesting and challenging as possible.

Our soil scientists must be scientists. They need to keep abreast of the science and maintain professional contacts. That means they must READ, become active in professional groups and associations, and have opportunities for self-improvement. I know many of you have developed opportunities for self-improvement activities within the partnership, and I applaud you for these efforts. The Soil Science Society of American may not be for everyone, but it is the flagship professional society for soil scientists. We must maintain contact with the society and provide our field soil scientists an opportunity to present papers at the SSSA meetings. After all, who knows more about the soil-landscape relationship than our field staff? With respect to reading, our soil scientists need access to professional journals so they have an opportunity to keep up on the latest research.

We need to maintain an active university presence in soil survey or pedology. The focus of pedologic research must expand to include interdisciplinary studies that address soil survey applications in the arena of technical soil services. We, NRCS, must be proactive in working with university partners to help them obtain research grants. We also need to work with university administrations to ensure they fill behind pedology professors. Horace and I are more than willing to work with you and visit with university administrations on these issues.

Soil Surveys—The Process and the Product

We have a proven scientific method for conducting the soil survey. Our recently revised *Soil Taxonomy* is used worldwide, we have a National Soil Survey Information System that houses a soil database worth billions of dollars and is the envy of the world, and we are well on our way to providing soil survey information over the Internet. So what's left for us to do? We must continue to evaluate the field model for soil survey to ensure that our science is current with the new analytical, geotechnical, and digital tools at our disposal. In addition, we need to move from a process of what some have called a patchwork approach of doing soil surveys on a county-by-county basis to a process that allows a continuous product across county lines and provides the opportunity for a continuous update of the survey. Healthy organizations are constantly reevaluating the way they do business. It is healthy for soil survey to continue to revisit the philosophical approach of soil survey. I challenge our research partners and our NRCS leaders to jointly research the science of soil survey and to publish papers about the science and concepts of soil survey. We must start this dialogue immediately.

Together, we are well along in the process of putting the management structure in place for the Major Land Resource Area (MLRA) approach to soil survey. I know it has been difficult for many of the partners. We truly appreciate your willingness to work with us as we put together a partnership centered on the MLRA approach to soil survey. However, I sense that we are struggling a bit with the scientific and operational processes for conducting an MLRA survey. It is absolutely crucial that we perfect the science of updating and maintaining soil surveys on an MLRA basis to ensure consistency of our product across geopolitical lines and to develop the most efficient means of updating soil

surveys. We need your help in exploring new and innovative methods of continually updating our product.

We have a tremendous opportunity to explore publishing soil surveys on the Web and make them more easily available to a wider user group. Publishing electronic products will also help us address the backlog of manuscripts for printing. We need your help to investigate how best to reach these user groups and make it happen. Perhaps we need to involve our social science colleagues in this endeavor.

Interpretation of the soil survey for site-specific farming is putting new demands on the soil survey product. We need a concerted research effort in both using the soil survey in site-specific farming and utilizing yield monitor data in understanding the soil survey. We have an opportunity to work with others to help farmers interpret yield maps using the soil survey and to discover what changes or additions are needed to make the survey more useful for site-specific farming. This is a prime example of where the soil-landscape model used to develop the survey could be extremely helpful in interpreting the map for these site-specific uses and in making sense of yield maps. Ann Veneman, our new Secretary of Agriculture, is very interested in getting new technology to farmers and ranchers and sees site-specific farming as one way of helping farmers become more efficient.

Earlier this year, we passed the 1000th milestone for the SSURGO digitizing project. That is a wonderful accomplishment, and we owe each of you a debt of gratitude for the commitment you have made to the digitizing initiative. While the SSURGO product is in high demand by the high-end GIS user, we still have some work to do to make the soil survey product useful to the general public. I know that some of you are researching innovative ways of making the product more useful to the general public. I encourage you to continue these efforts, as getting soil surveys in the hands of the public is critical to the continuing success of the program. I am very impressed with the award-winning Lighthouse project for serving soil survey and related data. Our information technology staff here in Fort Collins is developing this process, which is easy to use and requires little software at the user's computer. Continuing research and development activities on making the data and information accessible are crucial to the success of the soil survey.

Finally, we need to ask ourselves why society should keep funding the soil survey program? Can we find champions for the soil survey program? What are you doing in your states to identify these champions? You at the state level, whether as State Soil Scientists, other agency personnel, or university professors, are in pivotal positions for identifying potential champions for the program and developing the necessary contacts to further the program. I do have one concern with the completion of what I call the initial soil survey and that is in the West, where we have large areas of public and private lands left to map. Oftentimes these lands are intermingled so that it is impractical to map only private lands. We need to solve this problem jointly with our public land partners, and I encourage you to develop a dialogue at this meeting of possible ways that we can address the issue.

Development of Technology

I want to talk about three areas of technology, knowing that I am leaving out other important things. These areas are GIS, nondestructive geophysical investigations, and laser technology for in situ measurement of soil properties.

I have talked about GIS before and the need to fully utilize our digital geospatial data. The potential for the use of GIS through our soil survey operations and interpretations is almost unlimited. We have only scratched the surface with respect to utilizing our geospatial data. We are extremely good at the mechanics of using GIS and generating interpretative maps, but we are only just beginning to use statistical approaches to more fully explore the many nuggets of information contained within the geospatial data. The research possibilities in GIS and data mining are almost limitless. We need research scientists looking at new ways of mining this rich data source.

This past spring, I attended a briefing on the Soil-Landscape Interpretations Model (SoLIM) being developed at the University of Wisconsin. This model has great potential for documenting landscape models we use in mapping soils. Not only will the system document these models in GIS, but it can be used to generate soil boundaries on a map for use in mapping activities. Thus, the landscape models can be tested and used to assist soil scientists in the soil survey process while documenting the model for later use in interpreting the data.

We have made great strides in the use of ground-penetrating radar and electromagnetic induction. These tools are extremely valuable in some soils and are not as useful in others. We need to continue to explore the use of these tools and others to assist in soil survey activities. As I visit with soil scientists around the country, our conversations often gravitate to the problems of mapping in areas where it is difficult to dig and explore soil properties with depth. The soils could be stony or have dense layers. We need nondestructive methods to help soil scientists accurately map these soils without trying to beat a spade around the stones or dense layer. Again, our research partners can help us explore new tools for mapping soils.

I am extremely excited about the laser technology being developed at the Los Alamos National Laboratory (LANL). The instrument under development can measure total carbon in situ either along the side of a pit or through an access hole. In addition to total carbon, the instrument can get most of the elements on the periodic table! We are working with LANL this year to further refine the instrument for use in the agency. One of the process issues to address is taking a representative reading, since the laser focuses on a very small volume of soil.

Technical Soil Services

Technical soil services are crucial to the success of the soil survey program. They are the main part of the outreach to the general public and user of the information. We need to commit ourselves in this partnership to developing the technology for soil scientists to

perform technical soil services whether they are in the public or private sector. We need research on new and innovative ways of using the basic soil survey information to solve land use and other issues concerning the soil. We need to work with social scientists in perfecting the way we apply and deliver our product to the public.

Earlier, I talked about the need to scrutinize the science of soil survey. We also need to continue to scrutinize the partnership we call the National Cooperative Soil Survey. By this, I mean we need to maintain our current partnership and continually reach out and expand the partnership. The area of technical soil services provides a means for us to include some of the user groups in the partnership. We must be as inclusive as possible, or I am afraid that the answer to the question I posed earlier on (“Should society continue funding the program?”) will be NO because of ignorance of the program or lack of access to the information, not because we are providing an inferior product.

Summary

I see a bright future for the second century of soil survey. I think we are in the most exciting times ever in the life of the soil survey. We have electronic access to our product, we have wonderful new tools to map soils and to analyze the data, and we have many opportunities for research and development. First and foremost, we must attend to staffing and maintaining the scientific edge. We need to support pedology programs at our partnering universities. We need to continue to visit the scientific basis for the survey, especially with respect to the MLRA approach. We need to find new and innovative ways to mine our geospatial data. Finally, and most importantly, we need to get the product into the hands of the public.

Welcome to Colorado State University at Fort Collins!, by Lee Sommers, Dean, College of Agriculture, Colorado State University

Colorado State Univ.

23,000 students
\$150M extramural research

Agencies in Fort Collins

Estimated 1,000 PhD scientists
USDA-ARS, NRCS, APHIS,
FS, CDC, USGS, FWS, etc.
Colorado agencies - DOW

Objectives

Overview of Colorado
Change and growth
Agriculture
Colorado issues related to soil science
Soil science at CSU
Urbanization and Land Use
Farmland conversion
Technology will offset loss in production
Reasons to save farmland (American Farmland Trust)
Ensure food security
Create economic opportunity
Invest in community infrastructure
Protect natural resources
Sustain the quality of our lives

Population Growth in Colorado

Strong economy
Educated workforce
Technology friendly
Retirement locale
Impact
Water
Land

Impact of Urbanizing Colorado

Population growth
Infrastructure
Removal of prime farmland from production
Open space reduction
Wildlife impact

Forest-Urban Interface

Fuel accumulation
Property at risk
Fires will occur
Long-term impact
Revegetation
Erosion
Water quality

Country and Urban Conflicts

Property rights
Right to Farm laws
Animal welfare
Public lands
Grazing and logging issues
Water
Public good - rafting, endangered species
Sale to municipalities

Modernization

Industrialization of farming
Contract and large-scale operations
Community impacts
Biotechnology
Bt and 'Roundup Ready' crops
Marketing impact and consumer acceptance
Loss of consumer confidence i.e., Starlink

Personal Income—Farm Earnings

Colorado farm income will increase
Absolute number of jobs will decrease
Ongoing restructuring of agriculture
Farm size will increase
Vertical integration

Feeding a Growing World

Non-issue in U.S.
50% increase in farm price = 1.25% increase in food price
Global demand will continue
Losing farmland
Erosion
Salinization

Stewardship and Environment

Non-point pollution from agriculture
Nitrogen, phosphorus, and pesticides
Salinity
Erosion from cultivated land

Conservation tillage

Air quality

Dust

Carbon sequestration

Safe Food and Drinking Water

Consumer and producer concern

E. coli, Salmonella
Mad cow disease (BSE)

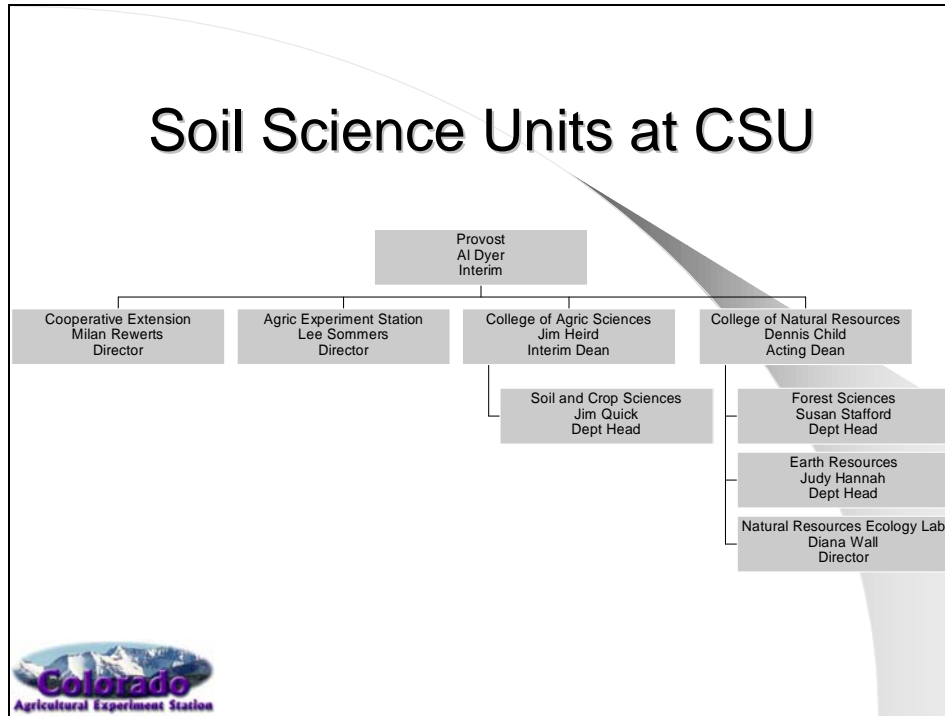
Drinking water

Nitrate and pesticides
Pesticide residues in food and water
Must balance with naturally occurring compounds
Colorado Agriculture
Livestock
70% beef
Increasing dairy & pork
Decreasing sheep

Crops

Wheat, corn, hay
Potatoes & dry beans

Green Industry +\$1B



Soil Science Program Areas

Soil Chemistry

Ken Barbarick – University
Distinguished Teaching Scholar
Dean Heil
Parvis Soltanpour

Soil Physics and Irrigation

Greg Butters
Grant Cardon

Soil Microbiology

Keith Paustian

Soil Fertility and Management

Dwayne Westfall
Gary Peterson
Jessica Davis
Raj Khosla
Reagan Waskom – Water quality

Soil Genesis

Gene Kelly
Jan Cipra—GIS & analysis

Natural Resources

Forest Sciences

Dan Binkley
Indy Burke
Roger Hoffer – GIS

Earth Resources

John Stednick

Natural Resource Ecology Lab

Diana Wall

Cooperative Soil Survey Efforts in Colorado, by Robert Zebroski, Director, Colorado State Soil Conservation Board

My name is Bob Zebroski, and I am the director for the Colorado State Soil Conservation Board. The board is a division within the Colorado Department of Agriculture. There are 77 soil conservation districts in this State that the Board provides administrative and financial assistance to. There are 63 counties in Colorado. As you can see, the district boundaries are not always aligned with the county boundaries.

The State of Colorado encompasses 66,000,000 acres. Colorado's land is approximately 49 percent private, 36 percent Federal lands in forests and parks, 5 percent state owned, and 11 other land uses. Soil surveys are available—published or in draft—for about 95 percent of the State's private land and about 96 percent of the State's Federal land.

Growth is the major issue impacting the natural resources of Colorado. From 1987 to 1997, land was converted out of agriculture at a rate of 141,000 acres per year, or about 1/2 percent of remaining agricultural land converted per year. In the late half of the decade, the rate of conversion increased to 270,000 acres per year.

The population in the State of Colorado has been increasing at a tremendous rate. From the 1990 census to the 2000 census, the rate of increase has been 29 percent, bringing approximately one million new residents to the State. Fort Collins is located in Larimer County. In the last 10 years, there has been a 31 percent increase in the population of this county. There is one small town, Superior, just south of Fort Collins, that experienced an increase of more than 2,500 percent in its population during that period of time. Douglas County, which is located just south of Denver, has the distinction of being the fastest growing county in the United States for the last few years.

I bring all those figures to you to demonstrate the need for funds from the State for the completion of first generation soil surveys in seven counties (Montrose, Costilla, Gilpin, Teller, Park, Archuleta, and Las Animas). These are the same facts and figures that were used with the Colorado Legislature to obtain funding. The funding needed to complete the surveys in the next 6 years is anticipated to come from the Federal, State, and local governments as well as private sources. Without the additional funding, the soil surveys would not be available for 10 years. The State funds will accelerate the process and make the soil information readily available much sooner for the private citizens, governmental agencies, and consultants.

Let me share several examples of why the counties and municipalities are in need of the soils information. In 1999, one of the Nation's largest homebuilders agreed to cover millions of dollars in repairs to as many as 1,500 homes located southwest of Denver.

All these homes had basements damaged by swelling soils. These homes had been built on bentonite-laden soils. The estimate of the damages was 3.3 million dollars. When these bentonite soils become wet, the material swells, causing tremendous damage to the basements and the foundations of the homes. All of this could have been eliminated if

the homebuilder had paid attention to the soils information and made the necessary adjustments in the construction process.

The second example occurred in the western part of the Denver metro area. When the new subdivision was proposed, the local soil conservation district advised against construction of homes due to the potential soil hazards. The county planning staff also advised against construction. But the county commissioners ruled in favor of the developer. Soon after the homes were constructed, they began to slip down the steep hill. A lawsuit was filed, which resulted in the county buying the houses. Some of the homes were completely destroyed.

In both of the examples, the soils information was available but not used by the decision-makers. This emphasizes the need for an education effort to assist the users in the interpretation of the data, which must be in a useable form.

With current staffing levels, it is estimated that soil surveys on all privately owned land in Colorado will be available by 2005. Approximately 2 million acres remain to be mapped. In 1999, the General Assembly approved \$75,000 for soil surveys in Colorado. This was the first time that the State of Colorado has appropriated any funds for soil surveys. This funding was made possible only by the lobbying effort of the soil conservation districts and their partners. Contacts were made with key members of the Legislature through personal visits, telephone calls, and letters. Teller and Gilpin Counties are the location of gaming (gambling) activities in Colorado. Due to the high impacts on the natural resources for road and building construction, the Colorado Limited Gaming Control Commission became a partner in the funding of the surveys for these two counties.

The cost of completing the fieldwork for a soil survey is: Federal Government, \$1.60 per acre; private consultant, \$.80 per acre; and with the State funding, \$.60 per acre. This lower cost for the State funds is due to the partnership between the soil conservation districts and the Federal Government that allows the use of the existing Federal infrastructure. Additional office space, vehicles, or telephones are not needed in most cases. Other financial contributors for the soil survey program in Colorado include the U.S. Forest Service, counties, irrigation companies, mining companies, soil conservation districts, as well as private individuals. These contributions were approximately \$45,000 in past years.

Digitizing soils maps and developing databases are an integral part of today's soil survey projects. Currently, 20 surveys making up 28 percent of the private lands in Colorado have certified digital soil information available. About 37 million acres of private lands remain to be digitized. At the current rate, all lands will have digital soil information in 15 years.

Pedology and Soil Survey in the United States: Becoming Relevant in a Changing World, by David Hammer, University of Missouri, SSSA, S-5 Past Chair

Where have we come from and where are we going? My initial assignments--

- 1) "Talk about how SSSA and NRCS can link more effectively."
- 2) "How can university soil scientists interact more effectively with other soil science professionals?"

How do we resolve differences within a profession? We identify and focus on common goals—

As a profession, we have collaborated to address some major problems

- ✓ Soil erosion
- ✓ Crop yields
- ✓ Environmental quality
- ✓ Soil taxonomy

There is one major current global problem for soil science—feeding and sheltering a burgeoning population on a planet of finite space and resources.

Is there a more holistic model than the "Factors of Soil Formation," particularly when linked with Simonson's "Generalized Theory" (internal processes)? We need to use this model frequently and teach it to colleagues in related disciplines. It verifies our science and makes us relevant in a changing world.

We need to leave our comfort zone. We need to move beyond pedology and soil taxonomy for their own sakes. We need to identify problems and interact with scientists from other disciplines to solve problems. As part of this effort we need to be proactive.

- ✓ Defend our turf from those who practice soil science "without a license."
- ✓ Maintain standards, particularly in sampling and descriptive techniques.
- ✓ We are related historically to agriculture and should not neglect those roots, but we must expand beyond them into the larger landscape and into the rapidly growing rural/urban interface.

New technologies can help us. The best uses of these technologies are in data retention and analyses in a problem-solving mode.

What are our current challenges

- ✓ We have "shrunk" in numbers, particularly in academia.
- ✓ NRCS faces a large challenge in identifying new field personnel over the next 5-10 years.
- ✓ We are nearing completion of the "once over." I prefer to call this the "baseline soil inventory," and some people will assume our jobs have been completed with the soil survey.

Four major historical obstacles

1. When we finish, we have finished
 - A. The survey is a model based on a model, and many people don't understand this.

2. The modal pedon
 - A. Assumptions of homogeneity by non-soil scientists are common.
3. The taxonomy has become an introspective exercise.
 - A. Too complex for non-pedologists
 - B. Doesn't relate soils to landscapes
4. We haven't challenged and revised dated paradigms, and those without our experience still rely upon them. For example, most texts refer to the "C" horizon as "the underlying parent material," when the solum may have multiple parent materials.

Perspectives

- ✓ How do we view ourselves.
- ✓ How do others view us.

Perspective is the key, and we need to be viewed as the "environmental problem solvers," not just "people who work in the dirt."

Our model

- ✓ Hydrology should be the focus. It is a driving force behind pedogenesis and geomorphology.

Analogy—The fluvial system is to the landscape what the circulatory system is to the body. We can assess the hydrologic system on the basis of its physical attributes in the landscape and its dissolved and suspended loads.
- ✓ The interactions of water and soils are so intimate, complex, and necessary that they cannot be studied individually. We must study the system.

A suggested working hypothesis—Soils, landscapes, and their associated biota co-evolve through geologic time. Again, who has a more holistic model?
- ✓ We must focus on processes.
- ✓ We must use the landscape perspective.

Not a single good definition of "landscape" in the current landscape ecology texts. Suggested definition:
"A landscape is a population of landforms, welded geomorphically by the throughflows of water, nutrients, and energy."
- ✓ We must address scale issues in the landscape, because most other disciplines don't understand this issue.

Educate clientele that the map is a model.
- ✓ Most environmental problems are related to how human activities in the landscape affect water, both in quality and temporal volume distributions.
- ✓ The flood of '93

We must assume heterogeneity of the system, and that should be our guiding hypothesis. Then the local management questions are focused on the nuances of the heterogeneity.

- ✓ Which are the relevant soil/landscape attributes?
- ✓ How much do these attributes vary?
- ✓ Where do they vary?

- ✓ When do they vary?
- ✓ What causes the variation?
- ✓ What are the consequences of the variation for the intended land use?

This leads to enough work to keep us all busy for the next millennium.

This is where technology enters the picture.

Scale—many people don't understand the nuances of scale in maps and data.

Ground-truthing—how many useless GIS-layered maps have been produced?

New technologies

Site-specific products

Data archiving

Quality assurance

Seize the turf from the interlopers—

Engineers

The urban infrastructure

Sociologists

Urban runoff

Wildlife biologists

Gray's Lake

Alamosa

Ecologists

The gradient

Lack of documentation

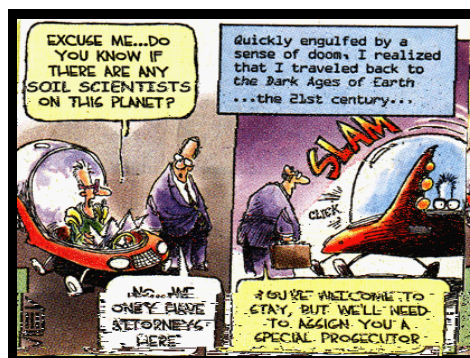
What can we do?

- ✓ Attend their meetings and present our approaches to inventory acquisition and problem-solving.
- ✓ Write their editors and help clarify and bring precision to their efforts at soil sampling and landscape description.
- ✓ Collaborate on campus—give lectures

What do clients want?

- ✓ Talk to someone who knows the system—specifically the person who made the map.
- ✓ Something specific in clear, precise English, rather than qualitative statements, such as “Moderately suited.”
- ✓ Cost effective in reasonable time.

As a profession, we must become more heavily involved in land use planning across the spectrum of society's applications.



We must set standards for interpreting soil and water responses to anthropogenic impacts:

Leave our “comfort zone.”

Become relevant problem solvers.

Become more entrepreneurial.

Become more aggressive at challenging the “interlopers.”

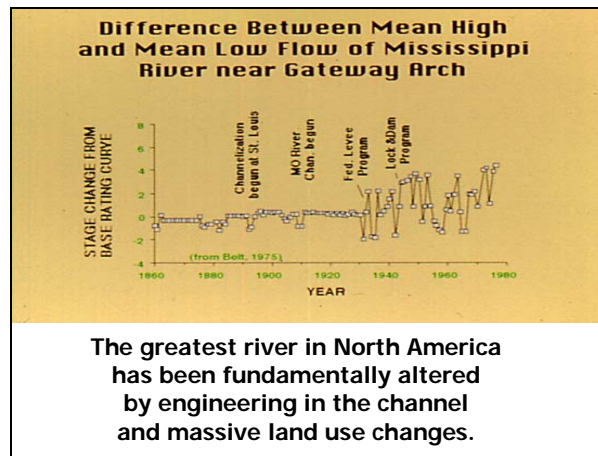
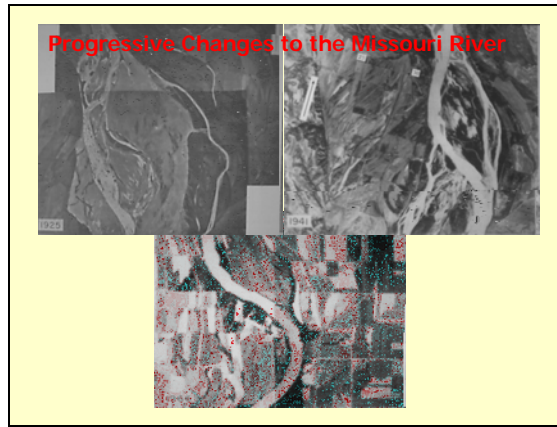
On our college campuses: Recent administrative trends focus program evaluations on enrollments rather than relevance.

We need to demonstrate our skills off campus and on. Examples:

- ✓ Jimmy Richardson was selected the outstanding faculty member on campus at North Dakota State University.
- ✓ Mickey Ransom was elected President of the Faculty Senate at Kansas State University.
- ✓ Kevin McSweeney is now a Dean.

Examples of why we need to move out of the comfort zone—

The City of Columbia, Missouri, hired an entomologist as the urba



Difference between mean high and mean low flow of the Mississippi River near Gateway Arch.

Channel engineering and massive land use changes have fundamentally altered the greatest river in North America, causing unprecedented problems during the flood of '93.)

The “basic laws” of ecology:

Everything is connected to everything else.

Everything has to go someplace.

There's no free lunch.

Nature bats last.

These all applied during the flood of '93.

Who better understands the roles of stratigraphy, soil attributes, and geomorphic features on the temporal and spatial distributions of water than practicing soil classifiers and pedologists?

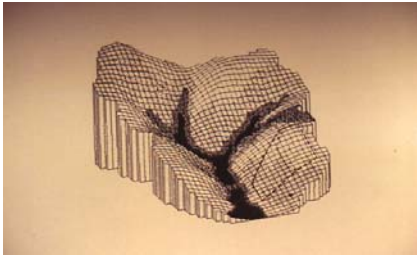
A soil survey is a Model.

The map units on the field sheet are models.

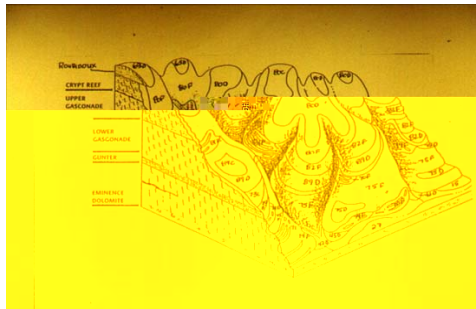
- Distributional attributes
- Scale

The taxonomy is a model.

The projected land use is a model.



GIS and allied technologies will allow us to develop more precise models -- provided we gather the appropriate field data.



The soil-landform paradigm is scale-adjustable.

Interpreting Soil Surveys

District Conservationists need more soil training, not less. Why should the person making interpretations of soil surveys have only 3 hours of course background when the person making the survey needs 15 hours?

Missouri soil survey users were nearly unanimous—

“Let us talk to the people who make the maps.”

Users also want access to data and quantitative “interpretations.”

GIS and allied technologies allow us to quantify and analyze soil attributes and archive data in ways not previously possible. We should catalog for future reference all possible information each time we make a site-specific investigation.

CARES (the Center for Agriculture, Resource and Environmental Sciences) in Missouri provides SSURGO attribute mapping through the Internet to anyone with a Web browser and Web connection. There are approximately 150 attributes that can be mapped from the MUIR data download in the SSURGO. All of these will be available on the Web within a few months. The attributes will be sorted by interpretations and by physical and chemical properties.

Soil mapping units overlaid with slope maps can be reviewed by soil scientists to determine if adjustments need to be made. Much of the drudgery of summing slopes by mapping unit and by individual polygon by the expected mapping unit component slopes can be executed using GIS technology. GIS analysts can perform many of these tasks with the aid of a soil scientist. CARES is providing rudimentary GIS query and analysis through the Internet. Here we have the example of an area query. What soil mapping units are in the box? The answer pops up to the right of the screen.

We have developed a system to obtain more information about individual soil map units. Using the Identify tool will immediately display the mapping unit name and polygon size and provide a hyperlink to the “Soil Interpretation and Limitation Report.” The interpretation tables provide 26 interpretations found in the MUIR download INTERP table. These are classed into five tables. Each interpretation is given a rating, explained by up to three reasons/limitations. The Sanitary Facilities table title is hyperlinked to the soil manuscript, if online, and to the Audrain manuscript if the particular manuscript is not yet available. Individual rows are readily found underneath the bookmarked heading. Hyperlinks are also available for Building Site Development, Construction Materials, Water Management, and Recreational Facilities.

We have to leave our comfort zone--

- Interact with local governments and user groups.
- (Academic) Become relevant on campus and off.

Help the K-12 teachers with environmental literacy.

- What should the average citizen know? Take the kids to the field. They will remember the experience and all they see.

Agency

- Raise standards; don't reduce them!
- Ensure that the public interacts with the appropriate “expert.”
- Try to identify a culture that encourages new ideas.
- Work together—advisory committee(s).

Examples of our paradigms—some cultural, some scientific

Assumptions of homogeneity—Jenny's soil N distributions across temperature and soil moisture “gradients” were hypothetical, and not based on actual data. They also are percentages of undefined surface samples, not quantities. Landscape evolution—most people assume a uniformitarian approach rather than evolution by extraordinary events. Have we, in our quest to classify, neglected the soil attributes as they relate to landscape position and processes? The “rectangular boundary” of the agricultural field defines the approach many take to the soil landscape.

Educating the next generation of clientele

Exciting, attracting, and educating the next generation of soil scientists is a challenge. They should be educated to interact with a broader spectrum of society, including politicians, planners, and attorneys.

Creating an environmentally literate population. Everyone should understand the hydrologic cycle and its relation to the genesis and co-evolution of soils and plants. Working with K-12 teachers. These are the people working with the youth. Give them the insights and materials to make earth sciences relevant, precise, and exciting.

The future is ours, and what we make of it is entirely up to us.

National Cooperative Soil Survey Conferences—Definition and Bylaws

602.00 Definition.

The National Cooperative Soil Survey (NCSS) coordinates technically and operationally at National, regional, and State levels. Its activities relate to the technology for the collection, management, and presentation of information about the properties, patterns, and responses of soils and to other joint concerns, such as training and coordinated research and operations. Workshops, meetings, and conferences are held at each level to discuss and resolve concerns, proposals, and recommendations for the cooperative soil survey.

(a) The National Cooperative Soil Survey Conference.

The national conference primarily discusses subjects of national concern to the NCSS. It is called in odd-numbered years by the Director Soil Survey Division, Natural Resources Conservation Service (NRCS), after consulting with the conference steering committee. The conference is attended by national representatives of cooperating agencies and institutions. Other interested foreign and domestic groups and individuals and particularly principal users of soil surveys are invited to participate. The proceedings of the conference are published and distributed to the cooperators in the NCSS. The objectives, membership, and committee responsibilities are specified in the conference bylaws. Refer to Exhibit 602-1 for the Bylaws of the National Cooperative Soil Survey Conference.

(b) The NCSS Regional Conferences.

The NCSS regional conferences primarily discuss subjects of regional concern. A soil survey conference is convened in each region in even-numbered years. The four regions correspond to the Agricultural Experiment Station regions and are the North Central, Northeastern, Southern, and Western. The conference is attended by state and regional soil survey leaders, some national leaders, and other invited persons. The conference proceedings are published and distributed to regional NCSS cooperators and others. The objectives, membership, and committee responsibilities are specified in the conference bylaws.

(c) NCSS State Conferences.

The NCSS state conferences primarily discuss subjects of state concern. A state conference is convened annually by the NRCS state soil scientist. It is attended by cooperators and others who contribute to NCSS activities at the state level and by principal users of soil survey information. Working agreements govern activities of the NCSS within the state.

(d) Joint Regional or State Conferences.

Joint regional or state conferences between two or more regions or states can be held with the agreement of the participants involved.

Exhibit 602-1 Bylaws of the National Cooperative Soil Survey Conference.

Article I. Name

Section 1.0 The name of the Conference shall be the National Cooperative Soil Survey (NCSS) Conference.

Article II. Objectives

- Section 1.0* The objective of the Conference is to contribute to the general human welfare by promoting the use of soil resource information and by developing recommendations for courses of action, including national policies and procedures, related to soil surveys and soil resource information.

Article III. Membership and Participants

- Section 1.0* Permanent chair of the Conference is Director Soil Survey Division, NRCS.
- Section 2.0* Permanent membership of the Conference shall consist of:
- Section 2.1.1* Members of the steering committee,
- Section 2.1.2* Two State members appointed by each of the four regional conferences and six NRCS lead soil scientists as members representing each of the six NRCS Regions,
- Section 2.1.3* Individuals designated by the Federal agencies listed in Appendix A.
- Section 2.1.4* Soil scientists from each of the six NRCS regional offices are included as members.
- Section 3.0* Participants of the Conference shall consist of:
- Section 3.1.1* Permanent members,
- Section 3.1.2* Individuals invited by the Steering Committee.

Article IV. Regional Conferences

- Section 1.0* Regional Conferences are organized in the northeast, north-central, southern, and western regions of the United States.
- Section 2.0* Regional Conferences determine their own membership requirements, officers, and number and kind of meetings.
- Section 3.0* Each Regional Conference adopts its own purpose, policies, and procedures, provided these are consistent with the bylaws and objectives of the NCSS Conference.
- Section 4.0* Each Regional Conference shall publish proceedings of regional meetings.

Article V. Executive Services

- Section 1.0* The National Headquarters Soils staff of the Natural Resources Conservation Service (NRCS) shall provide the Conference with executive services.
- Section 1.1* The Soils staff, NRCS, shall:
- Section 1.1.1* Carry out administrative duties assigned by the Steering Committee.

2001 National Cooperative Soil Survey Conference

- Section 1.1.2* Distribute draft committee reports to participants.
- Section 1.1.3* Issue announcements and invitations.
- Section 1.1.4* Prepare and distribute the program.
- Section 1.1.5* Make arrangements for lodging, food, meeting rooms, and, local transportation for official functions.
- Section 1.1.6* Provide a recorder.
- Section 1.1.7* Assemble and distribute the proceedings.
- Section 1.1.8* Provide publicity.
- Section 1.1.9* Maintain the Conference mailing list.
- Section 1.1.10* Maintain a record of all Conference proceedings; proceedings of Regional Conference meetings; and a copy of each Regional Conference's purpose, policies, and procedures.

Article VI. Steering Committee

- Section 1.0* The Conference shall have a Steering Committee.
- Section 1.1* The steering committee shall consist of:
 - Section 1.1.1* The Director Soil Survey Division, NRCS, is permanent chair and is responsible for all work of the Steering Committee.
 - Section 1.1.2* The U.S. Forest Service Soil Survey Leader.
 - Section 1.1.3* The Bureau of Land Management Senior Soil Scientist.
 - Section 1.1.4* Four Agriculture Experiment Station Soil Survey Leaders, one from each respective Regional Conference. This normally is the State representative that will be chair or vice chair of the next Regional Conference.
 - Section 1.1.5* Six NRCS soil survey staff leaders, to include representatives of the National Headquarters, National Soil Survey Center, and Regional soil staffs as determined by the Director Soil Survey Division, NRCS.
 - Section 1.1.6* The President-elect of the National Society of Consulting Soil Scientists, Inc., representing the private sector.
 - Section 1.1.7* A representative of the 1890 College from the vicinity of the next conference recommended by the Conference Chair.
 - Section 1.1.8* A representative of the Tribal College from the vicinity of the next conference recommended by the Conference Chair.
- Section 2.0* The Steering Committee shall select a vice chair for a 2-year term. The vice chair acts for the chair in the chair's absence or disability or as assigned.

2001 National Cooperative Soil Survey Conference

Section 3.0 The Steering Committee shall formulate policy and procedure for the Conference.

Section 4.0 The Steering Committee shall:

Section 4.1.1 Determine subjects to be discussed.

Section 4.1.2 Determine committees to be formed.

Section 4.1.3 Select committee chair and obtain their a

Article VIII. Committees

- Section 1.0* The committees of the Conference shall be determined by the Steering Committee. Permanent or standing committees, ad hoc committees, and task force groups are considered to be committees of the Conference. The Steering Committee shall select committee chairs.
- Section 2.0* Committee members shall be selected by the committee chairs. Committee members shall be selected after considering Steering Committee recommendations, Regional Conference recommendations, individual interests, technical proficiency, and continuity of the work. They are not limited to members of the National Cooperative Soil Survey.
- Section 3.0* Each committee commonly conducts its work by correspondence among committee members. Committee chairs shall provide their committee members with the charges as assigned by the Steering Committee and procedure for committee operation.
- Section 4.0* Each committee chair shall send copies of a draft committee report to the Steering Committee prior to the Conference.
- Section 5.0* Each committee shall report at the Conference.

Article IX. Amendments

- Section 1.0* The bylaws may be amended by ballot with a majority vote of the permanent members. An amendment shall, unless otherwise provided therein, be effective immediately upon adoption and shall remain in effect until changed.

APPENDIX A

MEMORANDUM OF UNDERSTANDINGS WITH THE NATURAL RESOURCES
CONSERVATION SERVICE IN THE NATIONAL COOPERATIVE SOIL SURVEY
CONFERENCE:

- Bureau of Indian Affairs, U.S. Department of the Interior
- Bureau of Land Management, U.S. Department of the Interior
- Bureau of Reclamation, U.S. Department of the Interior
- Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture
- Defense Mapping Agency, U.S. Department of Defense
- Economics and Statistics Service, U.S. Department of Agriculture
- Environmental Protection Agency
- Farm Services Agency, U.S. Department of Agriculture
- Forest Service, U.S. Department of Agriculture
- National Agricultural Statistics Service, U.S. Department of Agriculture
- National Institute of Standards and Technology, U.S. Department of Commerce
- National Oceanic and Atmospheric Administration, U.S. Department of Commerce
- National Park Service, U.S. Department of the Interior
- National Society of Consulting Soil Scientists, Inc.
- Office of Territorial Affairs, U.S. Department of the Interior
- Tennessee Valley Authority (quasi Federal)
- U.S. Army Corps of Engineers, U.S. Department of Defense
- U.S. Fish and Wildlife Service, U.S. Department of the Interior
- U.S. Food and Drug Administration, U.S. Department of Health and Human Services
- U.S. Geological Survey, U.S. Department of the Interior

2000 Regional Conferences

Northeast Cooperative Soil Survey Conference—Highlights and Recommendations

By Tyrone Goddard, NRCS, NY, and Edward Ciolkosz, Pennsylvania State University

Regional conference was held in Norfolk, VA, June 19-23, 2000.

The future NECSS Conference is planned for Thousand Lakes District, New York, June 24-28, 2002. Tyrone Goddard, SSS, NRCS NY, is Steering Team Chair. Ray Bryant, Cornell University, NY, has accepted a new position with ARS in Pennsylvania and will not be available to co-host the conference.

There was a suggestion from the Northeast Conference that the National meetings be held earlier in the summer. There were too many conflicts this year for representatives to attend. The NE Conference will search for a site and volunteer host for the 2003 National Conference in the NE.

There were three standing committees in the NE in 2000: Research Needs, Soil Taxonomy, and Hydric Soils (a combination of the New England and Mid-Atlantic Hydric Soils Committees).

Minutes of the NEC-50 Committee (Northeast Experiment Station Representative3 Tc w 0 -).TJ/TT1 1 T

members of NEC-50 be polled to help ensure that major conflicts with other meetings in the NE are avoided.

3. NEC-50 Committee Representatives.—The committee expressed its delight to have Bruce Vasilas actively participating on the committee (including his running of the 2001 field trip.) The committee received a communication from Ray Bryant indicating that he was leaving Cornell University in Ithaca, NY, to take a position as Research Leader for the USDA-ARS Pasture Systems and Watershed Research Management Lab in State College, PA, effective July 1. Ray indicated his appreciation and enjoyment of his collegial interactions with the NEC-50 Committee over the years and said that although he would no longer be a member of the committee, he hoped he would continue to have opportunities to interact with the group since he will continue to work in the NE region. The committee expressed concern over the impact of Ray's leaving Cornell and the NCSS. In addition to the obvious loss of having a representative from NY, the committee was also concerned to know who would be replacing Ray as chair of ICOMANTH.
4. Impact of NRCS Structural Changes on the NE Region.—As has often seemed the case in many years, there was discussion over how administrative and structural changes in NRCS would affect the NE region. It was the committee's understanding that Maxine Levin now has national responsibilities and also that the positions of Regional Soil Scientist have been abolished. The committee noted that several years ago the NRCS abolished the regional NTCs (the leaders of which traditionally had responsibilities for coordinating the Regional Work Planning Conferences). This task was then taken up by the Regional Soil Scientists (Maxine for the NE). Questions were raised regarding who would now take over this responsibility. Some thought that it may be Joyce Scheyer, but no one knew for certain.
5. 2003 NE Regional Pedology Field Trip.—Considerable discussion focused upon who should host the next (2003) field trip. It was agreed that while it would be great to have a trip in Maine, we should not at this time ask Laurie Osier to host the trip (rather we should give her a little more time to get settled in Maine and to have the opportunity to attend one or more field trips first). After much discussion, John Sencindiver said that he would explore the possibility of hosting the trip in WV, but he also acknowledged that over the next couple of years, WVU had several significant responsibilities and that he could not yet commit to hosting the trip. Ed Ciolkosz indicated that although he was unsure at this time whether or not he would be in a position to assist John with the field trip (perhaps by running a day or more in Pennsylvania), he said he would evaluate this possibility as the time approached.
6. Monoliths in the Smithsonian Institute.—A motion was adopted unanimously to endorse the proposal made earlier in the day by Patrick Drohan (of Shepherd's College, WV) to attempt to get the Smithsonian Institute to display a collection of

2001 National Cooperative Soil Survey Conference

soil monoliths from all 50 states, which are already available for their use (collected in conjunction with the Soil Survey Centennial).

7. Phriends of Phragmites.—Del Fanning explained to the group his interest in starting a group known as Phriends of Phragmites to help promote the value and wise use of the plant *Phragmites australis*. A number of concerns were raised by committee members, and no action was taken.

Meeting adjourned at 8:15 pm.

Submitted by Martin Rabenhorst

Southern Region Cooperative Soil Survey Conference

By Edward Ealy, NRCS, Athens, GA

Berman Hudson, Acting National Leader for Interpretations, presided over the meeting.

Southern Region Cooperative Soil Survey Conference NRCS Meeting included information on:

Publications:

Recommendation—the National Cooperative Soil Survey initiate policy to put forth BerDgu3o set A ng

Bill Puckett, MO 15 Leader/SSS-AL, volunteered to serve on the Southern Research Needs Committee to replace Craig Ditzler. The conference accepted his offer.

Berman Hudson agreed to check status/existence of Nation Research Needs Committee

Confirmed members of the Southern Hydric Soils committee
Universities

David Pettry—MSU (3 years)

Mike Vepraskas—NCSU (2 years)

Wayne Hudnall—LSU (1 year)

Larry West—UGA (3 years-starting in 2000)

The Information Exchange Group 22

Experiment Stations Representatives Meeting

Chair Dr. Tom Ammons, UT

V. Chair Dr. Larry West, UGA

Sec. Dr. Tom Hallmark, TAMU

Objectives

- ✓ Meeting Format
- ✓ Soils of the South
- ✓ STATSGO
- ✓ NRCS's Web - Database
- ✓ Conference purpose

The IEG 22 Southern Region Taxonomy Com.

Mary Collins—Jan. 1998 –Dec. 2000

Mike Vepraskas—Jan. 1999-Dec. 2001

Larry West—Jan. 2000-Dec. 2002

Moye Rutledge—Jan. 2001-Dec. 2003

Joey Shaw—Jan 2002-Dec. 2004

- ✓ Action Register—1998
- ✓ Include Univ. Rep. in Agency mtg.
- ✓ Voted to remove Virginia from the bylaws.
- ✓ Southern Research Needs Committee.
- ✓ Establish a Southern Region Ex. Station Home Page.
- ✓ Confirmed Chair of South Region Taxonomy Ct.
- ✓ Southern Region Hydric Soil Committee.
- ✓ Follow-up discussions from the June 1998 Conference.

Identify the process with specific tasks and methods required to "add value" for a MLRA soil survey. Identify partnership roles, responsibilities, and contributions
Identify and develop strategies or methods to be used to increase the visibility of soil resources and the use of soil resource inventory products. Develop a plan for collecting measured soil chemical and physical properties and KSAT.

2001 National Cooperative Soil Survey Conference

- ✓ Data must be accurate.
- ✓ List priorities.
- ✓ Data already available.

RECOMMENDATION: The SSD should encourage field soil scientists to gather data on hydraulic conductivity properties. Address plans developed by the regional conference and formulate a national strategy for populating NCSS database.

This recommendation was forwarded to the Regional Research Committee.

RECOMMENDATION: An action item for national conference next year should include an agenda item featuring new technology.

Voted to keep the format of the Southern Soils Conference. The 3-day length of meeting is efficient.

The work group voted to support Mississippi as the host for the 2002 Southern Soils Conference.

The committee supported the recommendation that NRCS update their Web databases. The committee continues their support for the Soils of the South project and Southern Experiment Station home page.

The committee appointed Mary Collins (UF), Moya Rutledge (UA), and Larry West (UGA) to investigate a regional project of training soil scientists. **Purpose** is to develop a project that all of NCSS cooperators in the southern region could contribute to. This would be a strategy to put the cooperative efforts back into soil survey in the region.

2002 Southern Regional Conference

Savannah, Georgia

June 10-14, 2002

Highlights and Recommendations from the North-Central Region

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Overview

The North-Central Region Soil Survey Planning Conference met the week of June 21, 2000, in Grand Rapids, Michigan. The conference included a midweek, 200-mile field trip examining soils, landscapes, and land use in southwest Michigan. Four committees met to discuss various issues related to soil survey:

1. Update of the North-Central Soil Survey Work Planning Conference Bylaws
2. Data Acquisition for Problem Solving
3. Research Needs for the North-Central Region
4. Hydric Soil Indicators for the North-Central Region

Breakout sessions were also held for USDA-NRCS and NCR-3, Soil Survey. This report includes key highlights and recommendations from these sessions as well as a meeting of NCR-3 that was held June 12 and 13, 2001, in St. Louis, Missouri.

Committee 1

The committee revised and updated the bylaws of the North-Central Regional Soil Survey Conference of the National Cooperative Soil Survey. The revised bylaws were approved at the business session of the conference.

Committee 2

Charge 1—What additional data are needed in NASIS?

1. Conduct a survey of NASIS users to see if they have suggestions to improve usability, add additional data elements, and evaluate if the database is meeting their needs. The survey should be completed before proceeding with additional population of the database. NASIS is designed to be flexible and could be easily changed if the survey suggests alterations should be made.
2. NASIS is intended to be used by soil scientists involved in the National Cooperative Soil Survey. Consequently, the appropriate group to survey is the current users of NASIS. However, NASIS will be made available to the public through a data warehouse. There may be additional data needed by non-traditional users of NASIS. Consequently, some form of user testing outside of the group of traditional users of NASIS is needed. Otherwise, we run the risk of only talking to ourselves and not being relevant to the broader scientific community.

Charge 2—Who will collect the data?

1. Encourage contributions to NASIS from scientists in the private sector, Federal, state, and local agencies and from other cooperators. These data will be subject to review by NRCS or university cooperators prior to entry into NASIS and must meet data quality standards.
2. Any data entered into NASIS will be made available to the public.
3. Within the context of NASIS, the data are “owned” by the entity that enters the data into the system. As such, close scrutiny must be given as to who will be allowed to enter data into NASIS.

Charge 3—Who will maintain the data?

1. The data in NASIS can be entered from multiple sources. NASIS is designed for users to be able to enter custom data elements that may be unique to a particular

region. Therefore, the maintenance should be the responsibility of the data “owner,” which is the entity that entered the data. In the case of data from the private sector, the data will need association with either NRCS or a traditional partner. As a policy, all potential users of NASIS should not be able to enter data into NASIS.

Charge 4—Estimated vs. measured data

Data in NASIS can be broken down into elements associated with data map units, components, or point data. All data elements for data map units and components are estimated, whereas those for point data are measured.

1. The user should be able to distinguish the type of data (measured, observed, estimated, reference, or null). This information can be assigned in the metadata. However, the information cannot be buried in such a way that the user is not aware of the status of the data. NASIS should clearly inform the user as to the status of the data.
2. There are varying levels of confidence associated with values for the data elements, depending on the number and quality of actual measurements used to derive the estimated value. Users should know the level of certainty associated with an estimated value. We suggest developing a data element that would provide several classes of rating the confidence of an estimate based on data quantity and quality. Also, some values for data elements are derived from algorithms. Users should be informed if a value is part of the original set of data entered into NASIS or if it was derived from the original set of data using an algorithm.

Committee 3—Research Needs in the North-Central Region

Charge 1—Review the 1997 report of the NCSS Research Agenda Standing Committee. This committee focused on a charge to identify, document, and address the critical research and development issues within the NCSS. Are there additional issues?

Additional priorities were identified as follows:

1. Baseline soil survey information, including discussion in soil survey manuscripts, should include soil quality and soil health. The baseline data should also include information on the concentration of heavy metals in benchmark soils. Some of these data are only used locally, such as heavy metal contents around smelters, and the local needs may not be the same as national needs.
2. Identification of the densic contact.
3. Research on urban soils and urban soil interpretations.

Charge 2—How can the visibility and credibility of the NCSS be increased?

1. Push for professional licensing and certification of soil scientists.
2. Promote the addition of soil science to the curriculum in the K–12 schools.
3. Include discussion of marketing issues at state soil survey work-planning conferences.

Committee 4—Hydric Soil Indicators

Charge 1—What problems exist with the hydric soil indicators in the North-Central Region?

1. The use of these indicators is directed to professional soil scientists, although the indicators are used by a large number of lay people with limited background in soil science.
2. A soil scientist is needed for the interpretation of the hydric soil indicators.

Charge 2—Which problems are limited to specific parts of the region?

1. Muck thickness in parts of Michigan.
2. Areas where hydric soils are buried by recent erosional sediment.

NRCS Breakout Session

The following key issues were discussed:

1. Time to input and edit the NASIS database
 - a. Resource soil scientists will have to prioritize tasks.
 - b. ArcView training will be required.
 - c. Computer equipment and connections will be needed.
 - d. Guidance from MO staff will be required.
 - e. A staff member on each soil survey project should be designated as the NASIS editor/trainer.
2. Replacement of an aging workforce in soil survey
 - a. Contacts should be made with career counselors, professors, student clubs, etc. at universities.
 - b. Selection process needs improvement.
 - c. Flexible work hours and locations will be needed.
 - d. OPM regulations can be limiting.
 - e. Communications should be improved between states.
 - f. Value of benefits of the job should be emphasized in recruiting.

NCR-3 Discussion at Meetings in Grand Rapids and St. Louis

The discussion included the following two issues:

1. University participation in the National Cooperative Soil Survey
 - a. Universities value the soil survey program and want to continue to actively participate.
 - b. University cooperators are encouraged to pursue competitive research grants that focus on current hot topics.
 - c. Some university administrators may not value participation in the soil survey program. As a result, it is difficult for the cooperator to actively participate.
 - d. The amount of time that university cooperators can spend on the soil survey program is often very limited.
2. Eroded soils proposal
 - a. NCR-3 noted that proposals from the Eroded Soils Committee were recently reviewed and rejected.
 - b. These proposals included a genetic link between eroded and uneroded soils and recognition of accelerated erosion as a diagnostic characteristic in Soil Taxonomy.
 - c. Concerns were expressed about the protocol for review of the recommendations and about how the decision to reject the proposal was reached.
 - d. In general, NCR-3 believes that there should be more discussion of taxonomic and technical issues within regional and national committees.

West Regional NCSS Conference Highlights and Recommendations

Chris Smith, State Soil Scientist, Hawaii

The WRNCSS conference was held in Kailua Kona on the island of Hawaii, June 25 - 30, 2000. The focus of the conference, in addition to communicating activities among participants and networking, was to increase the awareness of selected use interpretations and soil properties affecting them with the intent of encouraging a review of these interpretations and their criteria for soil survey.

Included in the conference proceedings are the presentations made by many of the cooperating agencies and universities. In addition, presentations were given that outline alternatives for the methods used to map soils, make recommendations for soil survey content (see Dr. Southard's presentation), and identify the need for agronomic interpretations, including inherent fertility characteristics and physical soil properties affecting management. A presentation of Soil Data Viewer by Terry Aho increased the group's awareness of this new soil information component in the NRCS Customer Service Toolkit that will be or is being used by conservation planners in the field offices.

In the NRCS breakout session, Bill Broderson noted the need to create a process to transfer new technologies for the West region to field personnel and between states and soil survey cooperators. The recommendation was to expand an existing Internet site called "Forums," renaming it "New Technologies and Soil Survey Forums," which would include new categories grouped by region. Also recommended was the development of a search engine allowing the linking to literature as well as the posting of soil survey information that has been peer reviewed within the state or region.

Russ Pringle's written submission noted that the Wetland Institute's funding for FY2000 has been sufficient only to pay salaries, with a small amount for support. Training provided has been funded by other Federal and state agencies.

Goro Uehara of the University of Hawaii presented a paper discussing the characteristics of pH-dependant charge soil materials as they relate to nitrate sorption and movement. He outlined the utility of measuring delta pH using H₂O pH and 1N KCl pH and the correlation to 1N K₂SO₄ delta pH. He noted that a KCl pH of -0.5 or greater can be used as an indicator of materials that possess significant amounts of positive charge shown to be effective at attenuating the downward movement of nitrate. Studies have shown that in addition to soil characteristics, the nature of the vadose zone is of major importance as well as past and future management and the moisture regime. The purpose of presenting this information is to encourage the creation of a set of soil interpretation criteria or rules specific to nitrate fate.

Russ Yost of UH presented information on phosphorous sorption and selected soil mineralogies. He then outlined the Hawaii approach to a P index model that he and the NRCS staff are developing called the "Phosphorous Risk Evaluator." This is a laptop-based interactive package allowing input of Ag system type, a variety of soil test P methods, distance to stream, watershed hydrology, nature of the stream, and nature of receiving ocean waters. The system does not provide a numeric ranking but does offer interpretations of conditions at each step of the data entry and management recommendations and summary recommendations with all components considered. GIS-based soils information is to be included to enable automated loading of pertinent soils and precipitation data and to provide a spatial backdrop for the conservationist and client.

My presentation sought to increase the group's awareness of the interactions of pesticides and soil materials with the intent of improving the soil leaching criteria and focussing specifically on leaching as it relates to pesticides. Outlined are interactions of polar and non-polar molecules with organic matter, negatively and positively charged clays. Also defined are common properties of pesticides expressed as K_d, K_{oc}, half life, and Henry's

on as we move increasingly into the environmental realm. Dr. Rebecca Burt of the National Soil Survey Laboratory brought us up to date on her work on this topic.

Prior to the week session, a tour was offered to Hawaii Volcanoes National Park. The narrative for the daylong tour consisted of a mix of geology, geomorphology, pedology, and local history. Dr. Bob Gavenda, then soil survey project leader for the Big Island, organized and presented the tour.

Mid week, Dr. Oliver Chadwick of UC Santa Barbara, organized, along with Bob Gavenda, a tour of the Kohala coast, presenting the plethora of data he and colleagues have collected on soil properties of volcanic ash as they vary by age, temperature, precipitation, and vegetation. Copies of the data-rich tour guide are available to serious users by contacting me at csmith@hi.nrcs.usda.gov. Bob and I conducted a post-conference tour on Oahu, highlighting the geomorphology of Oahu and the Oxisol/Ultisol landscapes and properties. The tour guide for this event is also available by contacting me.

Lastly, just prior to this writing, an issue has arisen relating to the development of RUSLE2. In keeping with the intent of the NCSS conference, I have taken the opportunity here and at the conference to note to participants an issue that affects us in the environments where poorly dispersed clays occur, such as Hawaii, the Pacific Basin, Puerto Rico, and the Virgin Islands. This condition may be approximated by the presence of 15-bar to measured clay ratios of 0.6 or greater via NSSL methods. Currently, in RUSLE2, clay percent entry is requested and is used to calculate detached sediment particle and aggregate size percent composition. These algorithms have been developed using data on these properties from soils of largely mixed or smectitic mineralogies and others which are typically adequately dispersed in PSDA. Where iron and aluminum cementation of clays is a significant feature, aggregation in terms of size distribution and amount can be very different, rendering the imbedded equations inapplicable. Gavenda, myself, Glen Weesies (NRCS National Agronomist), Samir El-Swaify of UH, George Foster (RUSLE2 modeler), and others think that for these materials, RUSLE2 can be modified to use databases of groups of particle size and aggregate information obtained from historical rain simulator plot's sediment analyses.

This modification would also benefit others across the country in areas where these materials exist, such as in certain spodic materials, diabase-derived soils of the Southeast piedmont, andic soils of the West and Northwest, oxic soils of the California Sierra foothills, coast range intrusives, and other areas of poorly dispersed clays. Only the initial teleconference has been conducted plus a search of Samir's 30-year-old raw data of sediment characteristics from rain simulator trials. Please contact me if your area contains these materials.

Committees and Task Forces

Standing Committees—General Descriptions

Research Agenda Standing Committee

Co-Chairs: Curtis Monger, New Mexico State University
Rebecca Burt, NRCS, NSSC, Lincoln, NE

Charges:

To establish a formal mechanism within the NCSS to:

1. Identify, document, prioritize, and address the critical research and development issues within the NCSS.
2. Identify opportunities for partnering on priority research needs.
3. Identify opportunities for funding priority research needs.
4. Increase the visibility and credibility of the NCSS.
5. Ensure the technical excellence of the NCSS.
6. Identify an Outstanding Research Project within the NCSS partnership to present at the National NCSS Conference.
7. The NCSS Research Agenda Standing Committee will be required to report its activities at each National Conference.

NCSS Standards Standing Committee

Co-Chairs: Bob Engel, NRCS, NSSC
Tim Sullivan, USFS, Colorado

Charges:

1. Define what standards are or what NCSS means by NCSS standards.
2. Receive recommendations from other regional committees and be the clearinghouse for issues dealing with standards.
3. Establish subcommittees to deal with issues identified.
4. Consider establishing subcommittees or collecting information from established committees of other groups to deal with the following areas of immediate importance:
 - a. NCSS data management standards (spatial and attribute data)
 - b. Soil landscape terminology (presently being addressed through interagency Federal committees approved FGDC)
5. Develop a methodology for distribution of standards and make recommendations back to the Steering Committee on the disposition of issues raised.
6. The NCSS Standards Standing Committee will be required to report its activities at each National Conference.

New Technology Standing Committee

Co-Chairs: Pete Biggam, NPS
Berman Hudson, NRCS, NSSC

Charges:

To develop and document procedures, processes, and standards that will be used to integrate GIS, remote sensing, landscape modeling, and other similar technologies into the mainstream of the soil mapping and landscape inventory program.

1. Review and document progress on recommendations from 1999 report.

2. Review and document progress on recommendations from 1999 Task Force on Soil Survey Products of the Future.
3. Review recommendations from 2000 Regional Conference reports.
4. Develop a methodology for distribution of standards and make recommendations back to the Steering Committee on the disposition of issues raised.
5. The NCSS New Technology Standing Committee will be required to report its activities at each National Conference.
6. Identify an Outstanding New Technology Transfer Project within the NCSS partnership to present at the National NCSS Conference.

In-Conference 2001 Committees—General Descriptions

Committee 1: Selling Soil Science to Society

Co-Chairs:

Barry Dutton, NPSS

Gary Muckel, NRCS, NSSC

This committee should consider issues concerning soil survey product identification, product delivery, marketing strategies, public access to expertise, product timeliness, and education on product use.

Charges:

1. Review 1999 committee report and 2000 regional conference reports with similar charges. Determine progress of recommendations from 1999 and 2000 meetings.
2. What soil survey products do users need/want, and how do they want them delivered?
3. How do we deliver products on time and on budget?
4. Develop market strategy to sell soil science to society.
5. Market evaluation analysis for soil survey.
6. Coordinate **Task Force 3: Feasibility Study to Create Internet Soils Library** and review product of Task Force for 2001 Conference.

Committee 2: Training for Pedology with Landscape Analysis

Co-Chairs:

Wayne Hudnall, LSU, Baton Rouge, LA

Earl Lockridge, NRCS, NSSC

This committee should review standard university curricula for soil scientists and evaluate how new soil scientists will get field mapping experience. With an emphasis on taxonomy in pedology, are there sufficient outlets for future soil scientists to develop skills in landscape analysis, geomorphology, GIS, and computer technology? What about soil management, monitoring, and assessment? Who will train the soil scientists of the future? What kinds of opportunities will there be for developing new partnerships for training?

Charges:

1. Who will train future soil scientists and how? (Consider classroom and field training.)
2. Review standard university curricula for soil scientists and evaluate how new soil scientists will get field mapping experience.
3. With an emphasis on taxonomy in pedology, are there sufficient outlets for future soil scientists to develop skills in landscape analysis, geomorphology, GIS, and computer technology?
4. What kind of training is needed for soil scientists in basic soil science and in soil survey? What kinds of opportunities will there be for developing new partnerships for training?
5. What are training recommendations to enhance skills for GIS and spatial statistics in soil survey?
6. Coordinate and review product from 2001 **Task Force 1: Soil Landscape Analysis Training Based on Soil Geomorphic Field Projects.**

Committee 3: Training for Use and Applications of Soil Survey

Co-Chairs:

Tim Wheeler, NRCS, CO

Larry West, UGA, Athens, GA

This committee is to concern itself with training for interpretation of soil survey data, data collection, use and application of interpretations, and information technology issues concerning the delivery of soil data and applications to the public and private sectors.

Charges (Address the following issues):

1. Review standard university curricula for soil scientists and evaluate how new soil scientists will get training for use and applications of soil survey.
2. What kind of training is needed for soil scientists in basic soil science and in applications of soil survey?
3. What are training recommendations to enhance or update skills for public and private sector soil scientists? An example—Are there outlets for training in soil management and soil resource monitoring and assessment (for watersheds and/or ecosystems) for field soil scientists?
4. What is the national strategy for data collection and data interpretation with the public at large?

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Committee 4: Recruitment and Retention of Soil Scientists in Soil Survey

Co-Chairs:

Bob McLeese, NRCS, IL

Richard Griffin, Prairie View A&M, TX

This committee is to concern itself with recruitment and retention of soil scientists in soil survey and soil resource management.

Charges (Address the following issues):

1. Investigate what incentives and programs are available to the NCSS to recruit soil scientists with the Office of Personnel Management for the Federal Government.
 2. What are the reasons that students do not apply for Federal jobs when they are made available?
 3. What impedes applicants from registering with OPM for such positions as soil scientist or soil conservationist?
 4. What scholarships are available nationwide that support students in soil science?
 5. Gather recommendations from past national and regional committee reports for retention of soil scientists in agencies and report on progress.
 6. Explore options for electronic or Internet clearinghouse that improve information flow on positions, student applicants, scholarships, grants, and contacts within NCSS.
 7. Coordinate and review product from 2001
- Task Force 2: Draft of Proposed New OPM Standards for Soil Scientists.**

Task Forces—General Descriptions

Task Force 1: Soil Landscape Analysis Training Based on Soil Geomorphic Field Projects

Develop detailed course outlines and an implementation plan for four regional Soil Landscape Analysis training courses based on four major soil landscape and geomorphic field studies. These studies are the Desert Project in New Mexico, Willamette Valley in Oregon, the North Carolina Project (Coastal Plain and Piedmont), and the Ruhe's Iowa Project (Glaciation).

Task Force 2: Draft of Proposed New OPM Standards for Soil Scientists

Develop draft of proposed new OPM standards for soil scientists. Work with OPM contacts and personnel contacts in Federal agencies for guidance on procedures, format, and content.

Task Force 3: Feasibility Study to Create Internet Soils Library

Produce a feasibility study to evaluate the workability of creating an "Internet Soils Library" that combines both Federal and university sources of lab data, soil profile descriptions (with photos), landscapes (with photos), and Soil Taxonomy into a Web-accessible system for the public and private sectors. Independent soil reference systems would be accessed by links or search engines.

Committee Reports

Research Agenda Standing Committee

Rebecca Burt and Curtis Monger, Co-Chairs

I. INTRODUCTION

A Standing Committee was formally established for the National Cooperative Soil Survey (NCSS) Research Agenda by the NCSS Conference Steering Committee as per a recommendation approved by the Steering Committee (8/8/95) published in the Proceedings of the NCSS Conference, San Diego, California, July 10-14, 1995. The implementation of this recommendation is discussed in detail in the NCSS Conference Proceedings, Baton Rouge, Louisiana, June 16-20, 1997. Co-Chairs of the Research Agenda Standing Committee (1995-1999) were John Kimble, Research Soil Scientist, National Soil Survey Center (NSSC), and Larry Wilding, Professor of Pedology, Texas A&M University. This 1997 report outlines the basic charges and responsibilities of the committee and serves as reference documentation for the 2001 report.

At the NCSS Conference in St. Louis, Missouri (June 27–July 2, 1999), the Steering Committee concurred with the recommendation that Curtis Monger, Professor of Pedology, New Mexico State University, and Rebecca Burt, Research Soil Scientist, NSSC, Lincoln, Nebraska, serve as Co-Chairs of the Research Agenda Standing Committee. In June 2000, the four regional conferences (North-Central, West, Southeast, and Northeast) met in Grand Rapids, Michigan; Kailua-Kona, Big Island, Hawaii; Auburn, Alabama; and Newport News, Virginia, respectively. Two representatives from each regional research committee were chosen to serve on the national Research Agenda Standing Committee. In addition, representatives from BLM and USFS and other NRCS personnel were asked to serve on this national committee. See section on committee members.

Following the establishment of the current membership of the Research Agenda Standing Committee, a draft report was forwarded to all committee members in March 2001. This draft summary report was based on the following resource materials: (1) Minutes of Research Needs Committee reports from the North-Central, West, Southeast, and Northeast and (2) Summary of research projects at the USDA-NRCS, National Soil Survey Center, in collaboration with NCSS Cooperators. Responses from committee members were assimilated into the final report.

The functions of the national research committee and the respective regional conference committees are similar, and as such, the national report is primarily a consolidation of these four regional reports. It outlines the seven charges given to the committee, with primary emphasis upon charge 1, “Identify, document, prioritize, and address the critical research and development issues within the NCSS.” The 1997 NCSS Research Agenda Standing Committee Report stated:

It is clear there is wide diversity in scope and priorities of research thrusts among partners in the NCSS program. Research in different states among different partners addresses local or regional priorities which are most

germane to the specific area. This seems appropriate. It is certainly not the intent of this Committee to direct or mandate a uniform national research agenda upon partners constituencies. Rather the purpose of this Committee is to help facilitate, nurture, and identify research priority areas that have a common national thread, and where identification of these areas may foster synergistic thrusts among partners with diverse expertise and expectations.

II. RESEARCH AGENDA STANDING COMMITTEE

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III. CHARGES TO COMMITTEE

The following seven charges were assigned to the committee to establish a formal mechanism within the NCSS to:

1. Identify, document, prioritize, and address the critical research and development issues within the NCSS.
2. Identify opportunities for partnering on priority research needs.
3. Identify opportunities for funding priority research needs.
4. Increase the visibility and credibility of the NCSS.
5. Ensure the technical excellence of the NCSS.
6. Identify an Outstanding Research Project within the NCSS partnership to present at the NCSS Conference.
7. The NCSS Research Agenda Standing Committee will be required to report its activities at each National Conference.

During the time that this standing committee has been active, most of the effort has been given to charges 1 and 6. General aspects of charges 2-5 have been considered, but future work of the committee will address these items. Charge 7 will summarize charges 1-6.

IV. COMMITTEE RESPONSE TO CHARGES

Charge 1: Identify, document, prioritize, and address the critical research and development issues within the NCSS

This report enumerates and summarizes many research projects/needs in the NCSS. These summaries are presented in several formats, depending on the forum in which they were collected. Some summaries are presented as ongoing activities, whereas others are presented as research proposals for future needs. In this report, the research summaries of on-going projects are presented by principal investigator in the Western Region, by project activity in the Southeastern Region, and by broad topical areas at the NSSC. In

the Northeast Region, summaries are presented as research proposals by topical area. In the North-Central Region, the research priorities designated in the 1997 NCSS Research Agenda Standing Committee Report are discussed, with additional recommendations by the 2000 regional committee. Regardless of format, research is a continuum—a dynamic process whereby ongoing investigations foster new hypotheses for testing and experimentation. These summaries of research activities/needs in the NCSS are diverse in expertise and broad in scope, reflecting the wide diversity of research priorities in the four regions. The intent of this report is not only to capture this diversity but also to share knowledge and provide linkages among NCSS cooperators so that critical national research themes can be identified and addressed.

A. West National Cooperative Soil Survey Conference, Western Coordinating Committee (WCC-093), Western Region Soil Survey and Inventory, Kailua-Kona, Big Island Hawaii, June 26–30, 2000

Randal J. Southard, Chair

1. David M. Hendricks, University of Arizona, Tucson

Kaibab Plateau: The Kaibab Plateau, the highest of several plateaus north of the Grand Canyon, is capped by the Kaibab formation (consisting of limestone and related calcareous sediments) and slopes downward toward the north. Five vegetation zones are identified extending from Engelmann spruce forest at the highest to a pinyon-juniper woodland at the lowest elevations. The soils on the nearly level plateau surfaces are deep, high or very high in content of clay, have strongly developed argillic horizons, and are free of carbonates (except the lowest elevation soils, which contain CaCO_3 at a depth of about 80 to 100 cm). These soils have formed from the residue following the dissolution and removal of carbonates, plus any eolian input. This suggests that the geomorphic surfaces have been stable for a long time under conditions as humid as or more humid than present conditions. The study of this elevation sequence is nearly complete.

Volcanic soils in Arizona: We have studied soil formation on basaltic tephra from three areas—the Springerville Volcanic Field in east-central Arizona, the San Francisco Volcanic Field near Flagstaff, and the Mormon Mountain Volcanic Field southwest of Flagstaff. Our current efforts are to determine the degree of eolian addition and admixture of dust and its influence on the evolution and properties of soils. For this study we are utilizing soils which have been previously characterized. Since these soils have formed in quartz-free (basaltic tephra) parent materials, our emphasis is on characterizing the nature of the quartz. Quartz is considered to be a ubiquitous component of dust (except basaltic ash). Quartz is also very resistant to chemical weathering and will tend to persist in soils without undergoing appreciable change. Our approach is to isolate the quartz by selective dissolution and determine its particle-size distribution (fine sand and silt fractions) using a laser optical particle-size analyzer. Larger grains (fine sand and coarse silt) are being analyzed by polarized light microscopy. Quartz grain surface features will be examined by SEM to provide additional information about their history.

Volcanic soils in Hawaii: Work continues with Oliver Chadwick, University of

California, Santa Barbara, and others on soil formation in Hawaii, with efforts to determine the quantitative mineralogy of the soils.

Other: Other studies with graduate students include the use of different types and amounts of amendments to improve irrigation water infiltration and a study of the effect of soil properties (amount and type of clay, quantity of "free" iron oxides, etc.) on the retention and movement of Cd. Teaching includes soil chemistry, soil genesis, and half of a soil chemical analysis course. Don Post (now retired) is continuing to teach soil morphology, classification, and survey.

2. Robert C. Graham, University of California, Riverside

The activity most directly related to NCSS is a project funded by USDA-NRCS entitled "Hydrologic and Ecosystem Functions of Paralithic Materials" with NRCS collaborators Phil Schoeneberger, NRCS-NSSC, Lincoln, NE, and Sam Indorante, NRCS, IL.

There is growing recognition that the upper 2 meters of soil is not the whole subsurface story for ecosystems, hydrology, environmental quality, and other land management issues. On residual landscapes, deeply weathered bedrock (paralithic material) is often a large component of the regolith and it has many soil-like attributes.

The objective is to determine the spatial distribution and soil-like properties of paralithic materials in the coterminous United States. To accomplish this goal, we took advantage of the vast amounts of data stored in NRCS databases: STATSGO, Official Series Descriptions, Series Classification, and National Soil Characterization Lab data.

Results: a) Paralithic materials underlie >10% of the land area. b) Water retention differences (between -33 and -1500 kPa) are similar to those of many soils, ranging from 0.10 to 0.22 cm/cm. They vary by lithology.

In comparison to watersheds underlain by hard rock, those underlain by paralithic materials supply water to plants longer into dry periods and have delayed drainage and surface runoff. Future needs include new strategies for investigating deep regoliths, a consistent system of describing soft bedrock materials, and inclusion of deeper regoliths in NRCS investigations and databases.

3. Randal J. Southard, University of California, Davis

Research continues on the health effects of mineral particles on human lungs and on the characterization of dust from agricultural sources in the Central Valley. We are using soil survey information (SSURGO and STATSGO)

Our results indicate that PM-10 concentrations decrease rapidly within a few tens of meters downwind of the dust source during almond harvest. The PM-2.5 concentration is much lower than PM-10, but the smaller particles travel much greater distances and may be a significant part of ambient PM-10 downwind. Silt loam, silty clay loam, and silty clay surface textures produce more PM-10 than clay and sandy loam surface textures. PM-10 from soils derived from Coast Range alluvium is dominated by smectite and altered biotite, whereas the PM-10 from Sierran-derived alluvium is dominated by altered biotite and plagioclase.

We are just starting new projects using soil survey information to identify soils with a high K-fixing capacity that are used for cotton production in the Central Valley and to estimate changes in C pools in agricultural and non-agricultural soils under various management and climatic schemes. These efforts will be based on STATSGO and SSURGO and will rely on field and lab studies to support GIS-aided predictions.

4. Eugene F. Kelly, Colorado State University, Fort Collins

Current Agricultural Experiment Station Activities Directly Related to NCSS:

Colorado Agricultural Experiment Station, “ Building Soil Landscape Models for Soil Inventories and Precision Farming,” \$ 76,622. July 1, 1999-June 30, 2001.

USDA-ARS, “Delivery of GIS and Web Based Models of Soil Processes,” \$218,000. October 1, 1999-September 30, 2001. (Co-PI’s: M. Schaffer, J. Cipra, B. Flynn)

National Park Service, “Soils resources in National Parks: Production of SSURGO data for use within the National Park System,” \$54,000. June 1, 2000-May 31, 2001.

USDA, “Use of GIS to Determine Nematode Occurrence in Platte River Basin,” \$170,00. January 1, 1998-December 31, 2000. (PI’s: D. Wall, R. Niles)

Current Pedology and Biogeochemistry Research Projects:

NSF-LTER, "Shortgrass Steppe," \$3,195,850. October 1, 1996-September 30, 2002. (Co-PI’s: W.K. Laurenroth, I.C. Burke, W. Parton, R. Pielke, B. Van Horne)

National Science Foundation, “Aggregate Turnover Controls on Soil Organic Matter: The Influence of Management and Mineralogy,” \$ 600,000. January 1, 2000-September 1, 2002. (Co-PI’s: K. Paustain, J. Six, E.T. Elliott)

National Science Foundation—Long Term Ecological Research. Supplemental Grant for Cross Site Comparisons. “Stable Si Isotope Geochemistry,” \$49,310. (PI’s: O.A. Chadwick, W.K. Laurenroth, I.C. Burke)

Graduate Students Currently Enrolled in Pedology-Biogeochemistry Program:

Elizabeth Sulzman, Ph.D., Biogeochemistry
Richard Bachaand, Ph.D., Forest Ecology
Suzanne Loadholt, M.S., Soil Science/Biogeochemistry
John Benner, M.S., Soil Science

Support Staff for Pedology Program at CSU:

Caroline Yonker, Research Associate (Pedology)
Jan Cipra, Research Associate (GIS)
Robert Flynn, Research Associate (Programmer)
Dan Reuss, Research Associate (Isotope Geochemistry)

5. Jerry Nielsen, Montana State University, Bozeman

The goals of related research are to provide economic and environmental benefits based on decision support tools and predictive models that merge knowledge of biological/agricultural processes with site-specific inventory knowledge of soil and microclimate attributes. Since soil water availability is the main driving variable in predictions of yield and crop nutrient needs, an objective is to create and test a conceptual model that integrates soil map units and terrain indices. The model will be used to predict soil water distribution and delineate soil management areas (i.e., an order 1 soil survey) based on soil water-supplying capabilities. Long et al. demonstrated that wheat in areas with high predicted soil water and aerial evidence of nitrogen deficiency benefited from late-season applications of nitrogen fertilizer that increased grain quality (protein) and yield valued at \$20/acre after application costs. In activities by Decker et al., SSURGO soil survey data are combined with remote sensing, terrain, and field boundary data as on-farm GIS layers. A Montana water-driven model is used to predict crop yield by soil map unit component based on stored plant-available water and probability of rainfall during the growing season. Crop yield data from GPS-referenced monitors on crop harvesters are added to the GIS and compared with SSURGO-predicted yields. Two learning groups, composed of farmers and ranchers, and of industry, agency, and university participants, work together on site-specific research. The farmers learning group pursues GIS strategies for on-farm research and now uses the same GIS programs (SS Toolbox, Surfer) to share ideas, data, and solutions to computer-related problems.

Another goal is to link NCSS data products with current-condition data acquired from space satellites. This work is supported by NASA through the Upper Midwest Aerospace Consortium (member states include MT, ID, WY, ND, and SD) and its Public Access Resource Center (AgPARC), which provides site-specific (farm- or ranch-scale) remote sensing information for agriculture. We deliver current AVHRR NDVI and Landsat 7 (and future MODIS) images to a dozen farmer/rancher members of learning groups. The goal is to create low-cost soil management maps and to monitor changes in crop and soil conditions (and indirectly, sequestered carbon) in ways that allow for scaling up and down. Earlier investigations demonstrated correlations between AVHRR NDVI and live-biomass ($r^2=0.64$) for six grassland areas where biomass was below 1,800 kg/ha. When

enhanced, this is a promising approach to tracking seasonal and yearly changes in forage biomass availability by soil map unit. A current project will allow rangeland managers to 1) evaluate the annual and seasonal productivity of their rangeland soil map units, 2) predict range readiness for timing and distribution of livestock use, and 3) assess automated tools on an ongoing basis for acquiring and analyzing soil survey and remotely sensed data that improve range management decisions.

Agroecosystems and land resources of the Northern Great Plains were mapped and characterized by Padbury et al. Major agroecosystems were described in terms of soil and landscape characteristics, with particular focus given to key climate parameters in relation to the new oilseed, pulse, and forage crops being introduced throughout the region.

6. H. Curtis Monger, New Mexico State University, Las Cruces

1. Teaching

Students enrolled as traditional soil science majors in agronomy departments are becoming less numerous. Instead, environmental science majors are growing in numbers. This is due to many factors. One important factor is probably name recognition. Middle schools and high schools now have courses entitled *environmental science*, so that when those students enter the university they have a sense of the discipline. Environmental science does not only deal with soil; it also deals with air and water. Perhaps environmental science will evolve into specialties as engineering evolved into specialties: electrical, civil, mechanical, and chemical engineering. If this is the case, then soil science may become soil environmental science. In any case, such courses as soil classification, soil genesis, and soil mineralogy should remain important classes.

2. Research Topics

The research currently being conducted by the Pedology Lab at NMSU deals with three topics. First, we are working with ecologists of the NSF-LTER program to quantify resource distribution at the landscape scale. This involves mapping soil-geomorphic units on which vegetation maps are overlain with GIS. This also involves making late Quaternary erosional and depositional maps in order to determine prehistoric fluxes of sediments. When combined with isotope and fossil pollen data, these maps are useful in understanding the ecogeomorphic evolution of the landscape.

The second area of research deals with biogenic formation of soil carbonate. Biological agents that precipitate carbonate include fungi, bacteria, roots, and termites. The fractionation of stable carbon isotopes by biotic agents is also being studied.

The third area deals with inorganic carbon fluxes within the carbon cycle. Primarily, we want to know the source of Ca, which we get at using Ca-isotopes, in order to assess the timespan of carbonate-carbon sequestration. We also want to know if inorganic carbon is similar to organic carbon by having both labile and recalcitrant pools.

3. Funding Sources

Funding for these projects has been supplied by the National Science Foundation, USDA-NRI program, International Arid Lands Consortium, and EPA.

7. Janis L. Boettinger, Utah State University, Logan

Our first objective was to continue to monitor the physical and chemical dynamics in a soil catena affected by seepage from upslope irrigation canals in central Utah. The soils possess various degrees of saturation and salinity, ranging from a naturally dry analogue to a strongly saline and seasonally saturated soil to two soils that are slightly saline and saturated throughout the year. We manually measured water level, pH, EC, and temperature of solutions in piezometers biweekly during the growing season and monthly in winter. Dataloggers record redox potential, soil temperature, and water table at the 30-cm depth every 2h. However, we removed pressure transducers and redox probes during the winter months to prevent equipment failure. This third year of data confirms our previous observations: the three soils affected by canal seepage were saturated and reduced within 30 cm of the soil surface during the microbial growing season and are hydric. Strongly expressed redoximorphic features can form in slightly saline soils in less than 110 years of artificial saturation. The strongly saline soil experiences microbial reduction in spite of poor expression of redoximorphic features. These results greatly improve our understanding of artificially wet soils, which are common in the western U.S., and of saline wetlands, which occur in naturally and artificially wet areas of semiarid, arid, and coastal regions.

Our second objective was to assess whether remotely sensed satellite data can facilitate soil inventory and interpretation in difficult-to-access areas of the Grand Staircase-Escalante National Monument, in which a cooperative soil survey is ongoing. The study focuses on the Circle Cliffs, which spans a well-defined section of middle and lower Mesozoic and upper Paleozoic sedimentary rocks and has a climate that ranges from ustic aridic to typic aridic. Soil mapping units were developed using traditional survey methods, and typical pedons were sampled for National Soil Survey Laboratory analysis. Due to repeatedly delayed launch of NASA's Terra satellite, which carries the new ASTER sensor that shows great promise for sensing surface soil properties, we are investigating alternative methods for facilitating soil inventory, such as Landsat 7 remotely sensed data and digital terrain analysis. With reduced budgets and personnel, it is essential that we improve the efficiency and accuracy of soil inventory and interpretation, especially in the vast and remote areas of the Western U.S.

Our results greatly improve our understanding of the origin, properties, and functions of artificial wetlands, which are common in irrigated areas, and of saline wetlands, which are a rapidly dwindling resource in the Western U.S. Soil survey methods can be improved using new remote sensing and GIS technologies, making soil inventory and interpretation more accurate and efficient.

The landscape of the artificially wet catena in Mancos shale near Castle Dale, Utah, is attached as a .jpg file. The cliffs of the Wasatch plateau are in the distance to the west. The trees in the background mark the line of the Bluecut ditch (the nearest of three upslope irrigation canals). The four small fenced areas mark each of the monitoring sites, left to right: 1) dry analogue (Torriorthent—Chipeta/Hanksville series, sparse greasewood and shadscale), 2) strongly saline and saturated within 30 cm in the summer only (Halaquept [not quite saline enough for the Aquisalid], Libbings series-like, saltgrass and greasewood), 3) slightly saline on slope with through flow of water, saturated within 30 cm most of year (Endoaquept—Rafael series?, *Juncus* spp.), 4) slightly saline in small depression, saturated within 30 cm throughout the year (Endoaquept—Rafael series, *Juncus* spp.).

8. Alan J. Busacca, Washington State University, Pullman

Modeling soils of the Sawtooth and Pasayten Wilderness areas, North Cascades, using terrain analysis, field studies, and GIS.

A 3-year cooperative project among Washington State University (WSU), the USDA-Forest Service, and the USDA-Natural Resources Conservation Service was started in 1998 to map the soils of the Sawtooth Wilderness Area and a portion of the Pasayten Wilderness Area at a fourth-order level using novel techniques. The project area is about 220,000 acres in size. WSU is providing the personnel and developing the methods used. The purpose is to obtain a resource inventory at modest cost for wilderness-type areas. More than 150 reference pedons were described during two field seasons in 1998 and 1999. Representative pedon descriptions are being prepared for integration into the national soils database. Sampling and mapping procedures were facilitated with the use of a GPS unit to capture site locations for later manipulation in a GIS. Since the 1999 field season, soil-landscape models in the GIS have been improved and tested. A decision-tree model to predict soil distribution is based on derived climate indices, potential natural vegetation, and primary and secondary terrain attributes, such as slope and wetness index, respectively. Additional digital information regarding bedrock geology, when it becomes available, will allow more precise modeling. Preliminary maps have been produced at 1:100,000 scale; components of mapping units are defined at the subgroup level of Soil Taxonomy. Parallel studies are underway to define the volcanic eruptions that have added tephra to these alpine landscapes and to define the critical factors controlling spodic horizon development in andic materials. Initial results were presented at the 1999 SSSA meetings in Salt Lake City: Indicators of albic horizon development in Spodosols of the North Cascade Range, Washington.

Other NCSS activities include technical field assistance by Alan Busacca for the Spokane County soil survey. Mr. Chris Miller of NRCS assisted Alan Busacca on a 3-day field trip for Busacca's Pedology class. Topics covered included genesis, morphology, and classification of Andisols, Alfisols, Vertisols, Mollisols, and Spodosols of the Cascade Range and Mount St. Helens area. Ms. Eva Muller of NRCS discussed career development in soil science, careers with Federal agencies, and how a soil survey project is organized and conducted with students in Busacca's Pedology course.

9. Chris Smith, USDA-NRCS, Hawaii, and Goro Uehara and Russell Yost, University of Hawaii (relevant papers presented at WNCSS conference)

Presently, the soil leaching rating uses as criteria: surface layer thickness, organic C content of surface layer, hydrologic soil group, and slope. The rating does not specify what substances is being rated for.

Anions, such as nitrate, are retarded in their leaching rate by AEC in pH-dependent clay systems, when acid. Delta pH using KCl and H₂O need not be net positive for AEC to be present (Uehara and Smith, discussion). Total soil depth and the depth and nature of the vadose zone are important factors. Research is currently being performed on P thresholds. Yet, P concentrations below threshold levels may be environmentally significant. Increases in P loading, while not at a critical threshold for solution losses, may be recycled into the food web once eroded to a water body in anaerobic sediment. P leachability in sands and thin Folist needs to be accounted for. Organic molecules also react with organic C below the surface layer. Those layers need to be considered. Mineralogy and ECEC and/or AEC affect ionic organic molecule retention (the longer the retention, the greater probability for decomposition).

A complete review of the rating system and revision of the soil leaching rating system are needed.

Goro Uehara of the University of Hawaii is conducting research on the characteristics of pH-dependent charge soil materials as they relate to nitrate sorption and movement. Outlined are the utility of measuring delta pH using H₂O pH and 1N KCl pH and the correlation to 1N K₂SO₄ delta pH. KCl pH of -0.5 or greater can be used as an indicator of materials that possess significant amounts of positive charge shown to be effective at attenuating the downward movement of nitrate. Studies have shown that in addition to soil characteristics, the nature of the vadose zone is of major importance as well as past and future management and moisture regime. The purpose of presenting this information is to encourage the creation of a set of soil interpretation criteria or rules specific to nitrate fate.

Russ Yost of UH is conducting research on phosphorous sorption and selected soil mineralogies. He uses a P index model that he and the NRCS staff are developing called the "Phosphorous Risk Evaluator." This is a laptop-based interactive package allowing input of Ag system type, a variety of soil test P methods, distance to stream, watershed hydrology, nature of the stream, and nature of receiving ocean waters. The system does not provide a numerical ranking but does offer interpretations of conditions at each step of the data entry and management recommendations and summary recommendations with all components considered. GIS-based soils information is to be included to enable automated loading of pertinent soils and precipitation data and to provide a spatial backdrop for the conservationist and client.

Chris Smith is interested studying the interactions of pesticides and soil materials with the intent of improving the soil leaching criteria and focusing specifically on leaching as

it relates to pesticides. Important in this regard are interactions of polar and non-polar molecules with organic matter, negatively and positively charged clays. Also important are the common properties of pesticides expressed as K_d , K_{oc} , half life, and Henry's partition coefficient. It is thought that a significant shortcoming of the present system is the omission of subsurface organic matter.

Also of importance in the future of soil information via the NCSS are obtaining and presenting information about background levels of heavy metals in the major soils of the U.S. Many NCSS workers are asked by the private sector what background levels are of various metals. This is an inherent soil property and within our purview to provide information on as we move increasingly into the environmental realm. Dr. Rebecca Burt and Mike Wilson are conducting research in this area.

RUSLE2 is affected by poorly dispersed clays in such areas as Hawaii, the Pacific Basin, Puerto Rico, and the Virgin Islands. This condition may be approximated by the presence of 15 bar to measured clay ratios of 0.6 or greater via NSSL methods. Currently, in RUSLE2, clay percent entry is requested and is used to calculate detached sediment particle and aggregate size percent composition. These algorithms have been developed using data on these properties from soils of largely mixed or smectitic mineralogies and others which are typically adequately dispersed in PASA. Where iron and aluminum cementation of clays is a significant feature, aggregation in terms of size distribution and amount can be very different, rendering the imbedded equations inapplicable. RUSLE2 can be modified to use databases of groups of particle size and aggregate information obtained from local USLE K-factor sediment runoff trials using a rain simulator.

This modification would also benefit others across the country where these materials exist, such as in certain spodic materials, diabase-derived soils of the Southeast piedmont, andic soils of the West and Southwest, oxic soils of the California Sierra foothills, coast range intrusives, and other poorly dispersed clays. Contact Chris Smith if you are interested in this topic.

B. Southeast Soil Survey Conference, Research Needs Committee, Auburn, Alabama, June 18-23, 2000

Wayne H. Hudnall, Chair

1. Soil Temperature—Thermic/Hyperthermic

Conrad Neitsch, Soil Scientist, NRCS, Temple, Texas; Mike Golden, State Soil Scientist/MO Leader, NRCS, Temple, Texas; Henry Mount, Soil Scientist, NRCS-NSSC, Lincoln, Nebraska.

Over the last 5-6 years, scattered measurements of soil temperature in the southern part of the thermic region proved to be above the range for thermic. This anecdotal evidence led to a dedicated study from Texas eastward to Georgia and Florida in the proximity of the current thermic/hyperthermic region.

2. Soil Color—Wet Soils—Annual Fluctuations

Jerry Daigle, State Soil Scientist, NRCS, Alexander, Louisiana; Wayne H. Hudnall, Dept. of Agronomy, Louisiana State University Agricultural Center; Ellis Benham, Research Soil Scientist, NRCS-NSSC, Lincoln, Nebraska.

Field soil scientists in Louisiana noted that soil colors recorded through the year changed from wet to dry times. A study was initiated to record readings by standard visual comparison with color chips and electronically by colorimeter.

3. Georgia—Palic and Kandic Diagnostic Features in MLRAs 133A and 153A in Southern Coastal Plain

Marc Crouch, Soil Scientist, NRCS, Raleigh, North Carolina.

Landscape in the lower Southern Coastal Plain and adjoining Atlantic Coast Flatwoods in the area is flat. Changes from one landform to another are difficult to follow, especi, NTc 0.028 12.05 0 T

of contaminants to a water table in Coastal Plain soils. (2) Work is in progress to test model parameters from Part 1 for specific cases of known soil contaminants.

6. Vertisol Climate Sequence on the Beaumont Formation in Texas.

Lee Nordt, Baylor; Steve Driese and Claudia Mora, Dept. of Geological Sciences, University of Tennessee, Knoxville, Tennessee; Jon Wiedenfeld, Soil Scientist, NRCS, Kountze, Texas; Wesley L. Miller, Wet Soil Specialist, NRCS, Victoria, Texas; Conrad Neitsch, Soil Scientist, NRCS, Temple, Texas; Warren Lynn, Research Soil Scientist, NRCS-NSSC, Lincoln, Nebraska.

The study extends from Beaumont, Texas, southwest to the edge of the Rio Grande valley. Soils are described and sampled at five locales; there are three sites in each locale (sites in the Beaumont, Houston, and Victoria locales have been sampled.). Analyses were done at Baylor Univ., Univ. of Tennessee, and NRCS Soil Survey Lab. Properties of this modern sequence are being compared to properties of paleoverdisols on the Cumberland Plateau and Appalachia.

7. Rehabilitating Rut Damage in Big Cypress Swamp, Florida

Bill Puckett, State Soil Scientist/MO Leader, NRCS, Auburn, Alabama; NPS; Univ. of Florida; Soil Quality Institute.

We are currently exploring opportunities with the NPS, the Univ. of Florida, and the Soil Quality Institute in Big Cypress in south Florida on rehabilitating rut damage on the shallow and moderately deep marl soils (potential research study).

8. Update of regional publication

Larry West, lead, University of Georgia

Plans are being initiated to update Southern Cooperative Series Bulletin No. 174 (1973), "Soil of the Southern States and Puerto Rico."

9. Effects of pH, Saturation, and the Addition of Sucrose on Iron Transformation from a Red River Soil in Louisiana

Jang-Hung Huang and Wayne H. Hudnall, Dept. of Agronomy, Louisiana State University Agricultural Center; Jerry J. Daigle, State Soil Scientist, NRCS, Alexander, Louisiana.

10. Soil Spatial Variability and C Stable Isotope Studies of Prairie-Forest Transition in Louisiana

Asfaw Bekele and Wayne H. Hudnall, Dept. of Agronomy, Louisiana State University Agricultural Center; Jerry J. Daigle, State Soil Scientist, NRCS, Alexander, Louisiana

11. Defining Growing Season from Measured Soil Temperature

Jacqueline A. Prudente and Wayne H. Hudnall, Dept. of Agronomy, Louisiana State University Agricultural Center; Jerry J. Daigle, State Soil Scientist, NRCS, Alexander, Louisiana

C. Northeast Soil Survey Conference, Research Needs Committee Newport News,

2. Quantification of Soil Organic Carbon Storage and Estimation of Carbon Storage Potential (CSP)

Purpose: To assist decision-makers in setting carbon credits based on environmental as well as political boundaries. Criteria will provide information for conservation of natural resources (i.e., own congressional districts).

Area of Emphasis: Nationwide

Project Description: Soil Organic Carbon Storage

Study soil C dynamics of land use change to soil depths of 20 cm, 1 meter, or greater, based on pedogenesis.

Improve estimation of existing SOC storage in different soils.

Link ecological surveys with underlying soil properties (on sites of varying SOC).

Develop method to partition C storage in plant biomass with soil C on a volumetric basis (interagency).

Stratify by MLRA.

Link to NRI for baseline data.

Expected Results and Deliverables: Quantification of Soil Organic Carbon (SOC)

Matrix of soils and land management practices to predict carbon storage potential (CSP).

Regional and national level improvements to existing computer models (such as CENTURY) using existing soil survey data.

Resources for Completion: 5 years, \$8 million

Primary Contacts: Dr. Laurie Osher, University of Maine; Steve Carpenter, NRCS

Submitted by: Northeast NCSS Research Needs Committee

3. Quantifying and Qualifying Hydrologic Indicators in Soils

Purpose: Measure and monitor wetland functions to improve understanding of the relationship between USDA National Hydric Soils Field Indicators, wetland functions according to the U.S. Army Corps of Engineers Hydrogeomorphic (HGM) wetland model, and other soil properties and soil hydrology. Fill gaps in the hydromorphologic knowledge base and site property database for all soil series that occur in wetlands.

National Emphasis and Priority: Identification, restoration, creation, and enhancement of wetlands to comply with Section (404) of the Clean Water Act and Food Security Act and other Federal programs associated with nutrient cycling, carbon sequestration, wetland inventory, wildlife habitat, rare and endangered plants, and water quality.

Project Description: Hydrologic Indicators

Inventory current research studies and surveys and compile the results according to HGM wetland type (URL http://itre.ncsu.edu/cte/hgm_print.html). Set up long-term (5-year) measuring and tracking (monitoring) of hydrologic changes and environmental

conditions in unstudied wetland soils, with paired sites in disturbed and undisturbed reference areas.

Conduct studies that correlate hydrology and site properties to allow extrapolation of results to similar but uninstrumented areas. Test and verify hydric soil indicators by Major Land Resource or Soil Survey Division Region with special emphasis on flood plains and problematic (dusky red, bright yellow, and dark gray/black) parent materials that have wetland hydrology yet do not exhibit hydric soil morphology. Measure and track hydrology dynamics in representative soils to distinguish current from relict redoximorphic features.

Expected Results and Deliverables: A refined water table record by HGM wetland type and NRCS soil series, including maximum and minimum height, seasonal occurrence, and duration. Sets of morphologic indicators for each type of wetland and for all associated soil series that indicate hydrologic dynamics.

Beneficiaries: Regulators of wetland use and management. Organizations that restore and mitigate wetlands voluntarily, such as The Nature Conservancy, USDA, and USFWS. Organizations and individuals that must comply with Federal regulatory policies. Organizations responsible for enforcing Federal regulations concerning use and management of wetlands. Policymakers who determine Federal regulatory programs and funding. Planners who design wetlands and storm-water retention basins in nonhydric upland soils.

Reference Sites:

Wetland Science Institute (URL <http://www.pwrc.usgs.gov/wli/>)

U.S.Army COE HGM (URL <http://www.wes.army.mil/el/wetlands/wlpubs.html>)

Penn State University Cooperative Wetlands Center

(URL <http://www.cas.psu.edu/docs/CASDEPT/FOREST/wetlands/cwchome.htm>)

Society of Wetland Scientists (URL <http://www.sws.org/>)

Field Indicators of Hydric Soils in the United States

(URL <http://www.statlab.iastate.edu/soils/hydric/fieldind/fieldind.html>)

Resources for Completion: 2 years literature review, data compilation, and site setup time, then 5 years of monitoring and 1 year of analysis and reporting. \$7 million.

Contact: Dr. John Galbraith, Virginia Tech

Reviewed by: Mid-Atlantic Hydric Soils Committee

Submitted by: Northeast NCSS Research Needs Committee

Additional Recommended Research Needs

4. Scaling of Data

Example is small wetland Histosols that often are lost in the map unit.

Note that the *Soil Science Society of America Journal* now requires taxonomic unit ID.

5. Accessibility to Data

Linking research data to mapped series

Web site links would be good for monoliths and research data on similar soils.

6. Forest Soil Nutrient Cycling

Ca, Mg, and Al saturation (some studies funded by the Forest Service)

Links to soil organic carbon

Link to water-quality and stream-quality data

Impacts of pollution on forest health/production/regeneration

Shallow soils with diagnostic horizons near the surface: Example of Suncook Spodosol under tillage becoming an Inceptisol

7. Anthropogenic Impacts on Soils

Properties, interpretations, and correlation

Highway Udothents-smooth commonly used

8. Regulated Materials

Background concentrations of metals, phosphorus, and other materials are needed.

Driving force for research is funding and politics, not scientific thresholds.

9. Soil Characterization to Support Soil Survey Updates

Ongoing basic genesis research for characterization

Vertisols and vertic subgroups

CEC activity groups

Glaucconitic soils

Soil compaction under various land uses, including urban uses

Fragipans and argillic horizons

Andic properties in cryic soils at high elevations

10. Application of Soil Databases

Digital SSURGO data going out to counties for planning

How do you produce an interpretation for a complex map unit when named soils and/or inclusions rate out differently?

Minzenmeyer's booklet on aggregating data is available.

Example: shrink-swell location in a map unit

Need geostatisticians to model and develop a template for examination of 1-2 critical properties as spatial variability. A deeper layer of GIS.

Public education

11. Precision Soil Management (PSM)

Guidance from NRCS is needed on applications of high-tech tools, such as GPR, portable XRF metal and organic detectors, hyperspectral data, & magnetic resonance (EM meter).

Example: McLeese prototypes.

What information from Order 2 soil surveys is useful for the transition?

Be able to defend our own product and assist with PSM objectives.

Develop standards for Order 1 mapping.

Committee 1: Research Needs Committee

Recommendations for NRCS Program Initiatives

2001 National Cooperative Soil Survey Conference

Ft. Collins, CO, June 20, 2001

Submitted by: Dr. John Galbraith

Area of Focus: Wetland Soils

1. Inventory current research studies and surveys and compile the results according to HGM wetland type (URL http://itre.ncsu.edu/cte/hgm_print.html).
2. Set up long-term (5-year) measuring and tracking (monitoring) of hydrologic changes and environmental conditions in unstudied wetland soils, with paired sites in disturbed and undisturbed reference areas.
3. Conduct studies to correlate hydrology and site properties to allow extrapolation of results to similar but uninstrumented areas.
4. Test and verify hydric soil indicators by Major Land Resource or Soil Survey Division Region with special emphasis on flood plains and problematic (dusky red, bright yellow, and dark gray/black) parent materials that have wetland hydrology yet do not exhibit hydric soil morphology.
5. Measure and track hydrology dynamics in representative soils to distinguish current from relict redoximorphic features.
6. Determine growing seasons for microbes, native herbaceous plants, native trees, turf/forages, and cropland.

Area of Focus: Other Soils

1. Continue funding soil temperature/moisture studies. The frigid line is unknown and probably incorrect in the Appalachians.
2. Establish soil interpretation research based on land use, and specify which land use the interpretation applies to. The old SOI-5 was land-use generic or biased toward the land use of the series typifying pedon.
3. Establish funding for soil interpretation studies in urban and suburban areas. This means septic systems/water quality/pollutant transport, soil compaction.
4. Continue/renew research funding for soil OC research that deals with inventory of three age pools, kinetics of gain in each pool, and potential sequestration by various vegetation/treatment types.

Area of Focus: Digital Soil Data and GIS

1. Populate the NASIS database tables.

2. Establish funding to assist in digitization of pedon data stored in university hard-copy form and entry into NSSL databanks and PDP program tables.
3. Establish funds to develop high-tech mapping procedures and tools, such as GIS and GPS, to provide SSURGO-level soils data in counties that lack Order 2 surveys and to facilitate more efficient mapping of the progressive survey areas.

D. North Central Soil Survey Conference
Committee 3: Research Needs
Grand Rapids, Michigan, June 18-22, 2000
Mickey D. Ransom, Chair

In the 1997 Research Agenda Standing Committee Report, research activities were grouped and later prioritized into six major issues as follows: (1) quantify field soil water regimes in landscape setting; (2) develop integrated scaling of research using a landscape approach; (3) develop baseline soil survey information to assess soil quality/soil health status; (4) quantify biological processes in soil systems; (5) quantify paleo versus modern properties and processes in soil systems; and (6) develop new technologies to enhance research capabilities and delivery of soil survey services. In 2000, Committee 3 provided a follow-up report on this 1997 national report and reviewed research needs in the North-Central Region as follows:

1. Quantify Field Soil Water Regimes in a Landscape Setting

We map soils in a drained condition, but interpretations are based on a natural (undrained) condition. (NASIS can handle and interpret both drained and undrained conditions if there is a need for this.)

We need to address water-quality issues (nutrient runoff, leaching potentials, etc.), but it may be more than we can do in current soil survey work.

We can make guides and make potential ratings.

Management is the key to some water-quality issues, although some are temporal properties.

Modelers usually want RV values, so we should provide the values. If not, they will decide what the RV values are on their own.

We need to develop tools for the management process. Funding is often tied to water quality. In some cases, we may need to give red flags to managers concerning water-quality values.

We need to gather data consistently. Data are needed for the length of saturation as well as for the length of reduction. To many users of soil survey, the length of saturation is most important.

We should gather data on a catena of soils, not just a specific site on a landscape. There is a need to understand the whole landscape soil hydrology.

Saturation is a problem if it occurs for less than 1 month, but this type of temporal data is difficult to show in a soil survey.

We need to compile and use existing data, and in some cases the data will need re-evaluation.

We should start looking at the Web and hyperlink technology to deliver soil data in the future.

Recommendation: This is still a research priority in the National Cooperative Soil Survey.

2. Develop Integrated Scaling of Research Using a Landscape Approach

We need to look at points raised in the 1997 report.

Although this priority is important for the North-Central Region, Committee 3 had difficulty understanding some of the issues raised.

Since site-specific management is such a big issue in the North-Central Region, it should be considered under this research priority.

This should also include the use of DEM and GIS

Recommendation: This research priority needs to be better defined and subdivided.

3. Develop Baseline Soil Survey Information to Assess Soil Quality/Soil Health

Soil quality researchers tend to study only the surface soil, but there is a need to look and quantify deeper in the profile.

There are existing guides that are used for identifying soil quality.

We need to partner with the Soil Quality Institute to improve efficiency and gain knowledge.

There are some natural differences between Mollisols and Ultisols. We should try to keep soils from degrading instead of trying to develop remediation procedures for soils that have been degraded.

Published soil surveys do not currently mention soil quality. We need to add soil quality to manuscripts.

We need to recognize the quality that soils have in a natural setting. Management will affect soil properties and soil quality.

We need to make soil quality data available to users in different and user friendly formats such as CD, Web, and GIS formats. The hard copy is becoming too restrictive for some users.

We should get baseline data for heavy metals on benchmark soils to follow how they degrade in the future. Some of these data, such as heavy metal contents around smelters, are of local use. The local needs for data may not be the same as national needs.

Recommendation: This is still a research priority in the National Cooperative Soil Survey.

4. Quantify Biological Processes in Soil Systems

This item is related to soil quality.

Recommendation: Add this item to number 3 above.

5. Quantify Paleo Versus Modern Properties and Processes in Soil Systems

In the North-Central Region, this is mostly related to the question of drained and undrained conditions. Some soils in the North-Central Region have redoximorphic features but no saturation if they are drained.

Recommendation: This is still a research priority in the National Cooperative Soil Survey.

6. Develop New Methodologies and Techniques to Enhance Research Capabilities and Delivery of Soil Survey Services

Recommendation: This is still a research priority need in the National Cooperative Soil Survey.

Additional Recommended Research Needs

7. Identify Densic Contacts.

8. Organize and Re-evaluate Existing Data.

The data should be in a format that all can access and use. Who owns the data will be an issue.

9. Research Urban Soils and Urban Soil Interpretations

Recommendation: Items 7, 8, and 9 will be added to the final report as additional research needs for the North Central Region.

E. Summary of Research Projects at the USDA-NRCS, National Soil Survey in Collaboration with NCSS Cooperators Lincoln, Nebraska, February, 2001

In general, research activities at the National Soil Survey Center are in collaboration with numerous NCSS cooperators and may be categorized under seven broad groupings: (1) soil carbon and biology; (2) soil phosphorus; (3) geophysics; (4) trace and major elements in soils: applications; (5) pedology; (6) soil climate; and (7) soil geomorphology. Individual summaries emphasize ongoing research activities that reflect current research needs of the NCSS. These summaries also include some future research needs and/or proposals.

Soil Carbon and Biology Studies

1. Soil Carbon Pools Under Various Land-Use Management Systems

Principal Investigators: J. Kimble, USDA-NRCS; R. Follett, USDA-ARS; R. Lal, Ohio State University; S. Samson-Liebig, USDA-NRCS; J. McCarthy, DOE, J. Jastrow, DOE.
Contact: John Kimble, john.kimble@usda.gov

Summary: Because of the Kyoto Protocols, there has been an increased interest in understanding the carbon pools in different ecosystems and how land use and land use management change them. One of the biggest problems faced by the IPCC was determining ways to measure and verify changes in carbon stocks. More detailed procedures are needed to look at changes in the different pools and how management affects them. Also, the pools need to be characterized; i.e., we need to go beyond just looking at total carbon. What are the effects of irrigation on SIC and SOC under no-till verses conventional tillage? What are the effects of heavy applications of manure under different cropping systems? How does erosion affect carbon storage? All of these are questions that need to be addressed if soils are going to be used as sinks for CO₂. The major benefit of this joint research is a much better understanding of the carbon dynamics in soils. We will know if soils are a sink or source of CO₂. With the knowledge gained, NRCS will be able to work with farmers who are interested in carbon sequestration.

2. Methodology and Assessment of Soil Carbon and Biology

Principal Investigators: C. Franks, J. Kimble, S. Samson-Liebig, K. Goings, and T. Sobecki, A. Tugel, R. Kelsea, E.C. Benham, USDA-NRCS; D. Post, University of Arizona; E.R. Ingham, Oregon State University. Contact: Carol Franks, 402-437-5178 ext. 33, carol.franks@nssc.nrcs.usda.gov

Emphasis and Potential Application:

Research will measure of components of carbon and biology in soils and will evaluate the impact of these properties on mapping, interpretations, and technical soil services. Efforts include adaptation of protocols for field sampling, near-surface observations, and database development. The research provides important information concerning soil function, microbes and climate, microbes and plant communities, microbial biodiversity, and management impacts. This work will consist of useful interagency inventories and modeling efforts related to global climate change, nutrient cycling, ecosystem modeling, and threshold identification.

Project-Related Areas:

- a. Field sampling protocols to develop, document, and implement appropriate field-sampling methods for biological analyses.
- b. Expanded organic carbon analyses to test the minimum dataset for organic carbon (Gregorich). Methods include POM, microbial biomass/activity, root biomass, labile C, C/N ratios, total C and N, and potential mineralizable N (aerobic).
- c. Microbial activity and biomass analysis to adapt, develop, and implement NSSL

capability to analyze fresh soil samples for microbial biomass determinations for CO₂ evolution by microbial respiration. Methods include CFI, NaOH titration, and gas chromatography.

- d. Database development for benchmark sites (of dynamic near-surface soil properties, plant communities, and management history), NRST/IRWET (soil biology), and soil food web (pilot project to link non-NRCS microbial data to the NRCS interpretive database [NASIS]).

Soil Phosphorus

3. National Benchmark Soil Phosphorus Project

Principal Investigators: M.D. Mays and M.A. Moustafa, USDA-NRCS. Contact: Dewayne Mays, 402-437-5138, dewayne.mays@nssc.nrcs.usda.gov.

Purpose: The NRCS is working cooperatively with ARS, EPA, CSREES, and cooperating universities to provide science-based data in support of a “National Benchmark Soil Phosphorus Project.” The Soil Survey Laboratory is providing analytical and technical support for the project to include methods testing and development.

Objectives: (a) determine threshold P levels in benchmark soils above which the potential for loss in surface runoff and subsurface flow increases dramatically. Relate these thresholds to an estimate of soil P sorption capacity, site hydrology, soil map units, and other soil and site characteristics; (b) develop a P index to identify and rank site vulnerability to P loss at field and watershed scales throughout the U.S. that can be easily implemented in a landscape setting; (c) integrate the soil P thresholds and P index information into a Comprehensive Nutrient Management Planning software package; (d) develop models that predict P loss at field and watershed scales, aggregate landscape processes, and extend the effects of distributed land use and management to reflect water-quality impacts.

Geophysics

4. Geophysical Program Initiative

Principal Investigators: J. Doolittle and other USDA-NRCS personnel. Contact: jdoolittle@fs.fed.us

Purpose: Establishment of Regional Soil Specialists (Geophysical Investigations).

Summary: This program initiative would provide a national network of a select few soil scientists and geophysical equipment on a MLRA regional basis to provide geophysical assistance to our users. In 1999, the status of geophysical techniques within the Soils Division and NRCS took a major leap forward. Three radar systems were updated and the Soil Survey Division provided funds and expertise to explore new technologies. The

FY 2000 initiatives included the development of regional soil specialists (geophysical investigations). This project would entail the National Soil Survey Division equipping selected MLRA offices with appropriate geophysical tools to conduct field investigations. In return for the equipment, the state would agree to provide a soil scientist(s) for up to 12 weeks to perform geophysical investigations within the home and adjoining states. NSSC personnel would train the designated soil scientist(s) on the use of GPR and EMI techniques. Specialist(s) would be responsible for the geophysical investigations within a restricted geographic area (home state and adjoining states). If the pilot project provides satisfactory results, the project can be repeated in additional MLRA offices. Three locations are recommended for the pilot project: Massachusetts (MLRA 12), western North Carolina (MLRA 13), and northeastern Colorado (MLRA 6).

5. Comparison of Two Electromagnetic Induction Tools in Salinity Appraisals

Principal Investigators: J. Doolittle, M. Petersen, and T. Wheeler, USDA-NRCS.
Contact: jdoolittle@fs.fed.us.

Summary: Electromagnetic induction (EMI) is a relatively low-cost and rapid method for measuring and mapping soil salinity over broad areas. This study compares apparent conductivity (EC_a) data obtained with single-frequency (EM38 meter) and multi-frequency (GEM300 sensor) EMI instruments and relates apparent conductivity measured by these instruments with the more conventional conductivity of the saturated extract (EC_e). Correlation coefficients between the EC_a data sets obtained with the two instruments were 0.80 and 0.86 in the horizontal and vertical dipole orientations, respectively. Although the GEM300 sensor produced higher apparent conductivity measurements and also predicted somewhat less accurately the conductivity of soil samples, spatial patterns of apparent and electrical conductivity produced by the two instruments were similar and reasonable. However, multifrequency sounding with the easier to operate GEM300 sensor was found to provide no additional information and did not improve interpretations over single frequency sounding. Article written and accepted for publication in the *Journal of Soil and Water Conservation*.

6. Comparing Three Geophysical Tools for Locating Sand Blows in Alluvial Soils of Southeast Missouri

Principal Investigators: J. Doolittle, S. Indorante, D. Potter, S. Hefner, and M. McCauley, USDA-NRCS. Contact: jdoolittle@fs.fed.us.

Summary: The level, moderately fine and fine textured, poorly and very poorly drained, alluvial soils of the southern Mississippi River Valley are well suited to rice production. However, in many areas, small inclusions of more rapidly permeable, coarse textured soils occur. Because of their more rapid permeability and associated higher operating and maintenance costs, these included soils are considered marginal for rice production. In this study, an EM38 meter, a GEM300 sensor, and a Veris 3100 soil EC mapping system were compared and used to assess the average clay content and the suitability of alluvial soils for rice production in southeastern Missouri. All three tools produced

similar spatial patterns of apparent conductivity. Major spatial patterns correspond to mapped soil delineations and changes in clay content. However, spatial patterns of apparent conductivity are more intricate than the major soil patterns and indicate soil map unit inclusions. Moderate correlations were found between apparent conductivity and average clay content. Correlations were lowest ($r = 0.39$ to 0.70) for the surface layer (0 to 25 cm). Correlations improved ($r = 0.63$ to 0.90) as the clay content was averaged over greater depth intervals (0 to 75 cm or 0 to 100 cm). As spatial patterns reflect differences in clay content, these tools can be used to help locate small included areas of coarser textured soils that might otherwise be overlooked. Paper being prepared for publication.

7. Use of Ground Penetrating Radar to Study Tree Roots in the Southeastern United States

Principal Investigators: J.R. Butnor, J.A. Doolittle, L. Kress, S. Cohen, D. Delea, and K.H. Johnsen, USDA-FS, USDA-NRCS, and Geophysical Survey Systems, Inc. Contact: John Butnor, jbutnor@fs.fed.us.

Summary: The objectives of this study are to assess the feasibility of using GPR to map coarse roots in the southeastern United States. Study sites were selected in the Southern Piedmont, Carolina Sandhills, and Atlantic Coast Flatwoods for assessment of the feasibility of GPR over a broad range of soil conditions. Studies addressed the selection of the best antenna and the ability to resolve roots and buried organic debris, assess root size, and gauge the practicality of using GPR at each site. Sixteen 1 x 1 meter plots in the Carolina Sandhills were scanned with the 1.5 GHz antenna using overlapping grids. The plots were later excavated, large roots mapped, and all roots classified by size and oven dried. Roots as small as 0.5 cm were detected with GPR. Resolution of roots was best in sandy, excessively drained soils, while soils with high moisture and clay contents seriously degraded resolution and observation depth. We were able to size roots (0.5 to 5 cm) that were oriented perpendicular to the radar sweep ($r^2 = 0.81$ $P = 0.0004$). Preliminary work using image analysis software to relate size/magnitude of radar parabolas to actual root biomass has shown significant correlations ($r^2 = 0.55$ $P = 0.0274$). Orientation and geometry of the reflective surface seem to have greater influence on parabola dimensions than root size. Results of this study were presented at the 16th Biennial North American Forest Biology Workshop, July 17-21, 2000, Merida, Yucatan, Mexico, and Advances in Terrestrial Ecosystem Carbon Inventory, Measurements and Monitoring, October 3-5, 2000, Raleigh, NC, USA. Article being prepared for publication.

8. Geophysical Surveys of a Carolina Bay in Robeson County, North Carolina

Principal Investigators: M. Vepraskas and J. R. Jenkins, North Carolina State University; J. Doolittle, USDA-NRCS; J. White, North Carolina State University; and B. Zanner, University of Nebraska. Contact: Jared R. Jenkins.

Summary: In December 2000, a ground-penetrating radar (GPR) survey was conducted

in Juniper Bay, a 296-ha Carolina Bay located south of Lumberton, NC. Its purpose was to detect the lateral extent of subsurface limiting horizons important to our intentions of restoring this Bay to a wetland. We collected continuous data along 57 transects. Ground truthing of GPR results was completed with 19 cores and additional shallower borings. The central and southeastern portions of the bay showed relatively flat-lying clay and organic layers at depths of up to 1.5 m. A buried surface horizon could be recognized in the GPR results. GPR revealed complex subsurface topography in the northwestern third of the bay, including steeply sloping bedding (A) along the southwest side of the bay and irregular subsurface topography (B) away from the rim. An initial interpretation of our findings suggests that erosional episodes left a mix of surface Pliocene and Cretaceous deposits, with stream channelization through the landscape where the bay later formed. The bay depression formed in sands that buried this erosion surface. Horizontal layers covered the sloping beds, perhaps before bay formation. Irregular topography out in the bay could be the result of sediment build-up around vegetation during low stands, or it may be erosional remnants of sediments accumulated during high stands and eroded during low stands. Horizons above this irregular topography are horizontally deposited, indicating that the recent history of the bay is a period of gradual infilling under wetter conditions that were likely interrupted by drier episodes. Paper being prepared for presentation at the Annual Meeting of the Southeast Section, Geological Society of America, Raleigh, NC, April 5-6, 2001.

Major and Trace Elements

9. Major and Trace Elements in Soils: Applications

Principal Investigators: R. Burt and M.A. Wilson, USDA-NRCS. Contact: Rebecca Burt, 402-437-5133, rebecca.burt@nssc.nrcs.usda.gov.

Summary: The USDA-NRCS Soil Survey Laboratory has developed methods to analyze soils for a suite of major elements (Si, Al, Mg, Fe, Ca, K, Na, Mn, P, Zr, and Ti) and trace elements (Cd, Cu, Co, Zn, Ni, Cr, Pb, and Hg). Procedures involve two methods using microwave digestion in a combination of acids (HNO₃, HCl, and/or HF) with the fine earth or other specific fractions ground to < 100-mesh. Digestions are analyzed for elemental concentrations using inductively coupled plasma (ICP) and cold-vapor atomic absorption spectrometry. Initial application studies with objectives related to soil survey include a few pilot projects (e.g., Montana, Wyoming, New York, and Oregon) with soils having either naturally or anthropogenically elevated metal concentrations. Other ongoing work in the area of application and interpretation of elemental data includes a systematic characterization of a large number of benchmark and other important soils to provide a database of elemental data from across the U.S. These data provide important information to soil survey users about the background levels of elements in soils and will better position the National Cooperative Soil Survey to address the needs of current and future clientele. The data will also be useful to those who evaluate pedon and landscape distribution of elements related to parent material and pedogenetic processes, such as leaching, podzolization, or oxidation-reduction. The data broaden the information relative to map unit composition and expand the application of soil surveys.

Pedology

10. Relict Paleosol Weathering Sequence on Andesite, Great Basin, USA

Principal Investigators: W.D. Nettleton, M.D. Mays, and R. Burt, USDA-NRCS. Contact: W. Dennis Nettleton, 402-437-5310, dennis.nettleton@nssc.nrcs.usda.gov.

Summary: The soils occur on surfaces shown to be Pleistocene by being separated from modern streams by one or more scarps. Elevations (E) range from 973 to 3,192 m, mean annual precipitation (MAP) from 20 to 55 cm, and mean annual soil temperature (MAST) from 3 to 16 C. The amount of OC and the level of BS, and likely depths to carbonate and salt as well, relate to the present-day climate in these soils. The accumulation of clay, FeCd, and kinds of clay minerals relate less well to the present-day climate and may be partly relicts of past climates. The MAST break at 8° C between frigid and mesic soil temperature families seems well placed for these soils. Accumulations of clay and FeCd in the soils at MAST > 8° C increase as MAP increases, whereas they decrease in the soils at MAST < 8 C as MAP increases.

11. Occurrence of Nitrate Nitrogen in Desert Soils

Principal Investigators: W.D. Nettleton and F.F. Peterson, USDA-NRCS. Contact: W. Dennis Nettleton, 402-437-5310, dennis.nettleton@nssc.nrcs.usda.gov

Summary: In an earlier study, Roger Parsons and others concluded that because similar soils occur on the five Pleistocene Spokane-flood terraces, the time factor in their genesis is negligible. Hence, the flood events forming the terraces would have occurred in rapid succession. Our work does not change that conclusion. However, there are differences in the soils. These we attribute to surface erosion following formation of the terraces and not to soil weathering. The mean vfs fraction tephra content of soils on the higher terrace ridges (11 percent) is significantly less than that on the lower terrace ridges (45 percent). The tephra content of soils in the troughs (77 percent) does not vary by terrace level. The allophane content of the youngest ridge is about 10 percent. This equals that of the youngest trough and is several times that of the highest ridge.

13. Prediction of Andisol Properties

Principal Investigators: W.D. Nettleton, S.H. Brownfield, E.C. Benham, R. Burt, K. Hipple, C.L. McGrath, and H.R. Sinclair, Jr., USDA-NRCS. Contact: W. Dennis Nettleton, 402-437-5310, dennis.nettleton@nssc.nrcs.usda.gov.

Studies by NRCS research soil scientists have shown that field descriptions for textures of Andisols correlate well with laboratory measured surface area indicators. The first indices were on Andisols in the northwestern USA. Total organic C is also predictable using elevation, precipitation, and mean annual soil temperature. Study is underway to provide field soil scientists models for predicting total organic carbon by horizon. Other models have been developed to predict other chemical properties of Andisols using total organic C and field estimated clay content.

14. Pedogenesis of Soils in the Blue Mountains of Oregon

15. Paleoverdisols

Principal Investigators: W.C. Lynn, USDA-NRCS; L. Nordt, Baylor University; S.G. Driese and C. I. Mora, University of Tennessee. Funded by NSF Grant. Contact: Warren Lynn, 402-437-5135, warren.lynn@nssc.nrcs.usda.gov.

Objective: Describe soils and collect samples from a climate sequence of Vertisols on the Beaumont Formation (lower coastal plain) from Beaumont, Texas (humid end) south and west to the edge of the Rio Grande Valley (dry end). The plan calls for a microhigh and microlow pedon at 15 sites, in clusters of three, spaced along sequence. Similar data gathered by Utah on paleosols in the rock record on the Cumberland Plateau and on older formations in Appalachia will be compared with the modern sequence to provide insight on depositional environment and weathering of the paleosols.

Summary: Ten sites have been sampled. Five are scheduled for sampling in May 2001. Texas NRCS selects sites and describes pedons. Utah does total analysis/mass balance and thin sections. The Soil Survey Lab provides standard characterization data. I have separated silt and sand fractions from large samples of two sites and removed carbonates from calcareous fractions in support of thesis work (Zr and Ti by xrf for sediment discontinuities and mass balance) at Baylor.

16. Wet Soils Monitoring Projects

Principal Investigators: W.C. Lynn, USDA-NRCS; C. Ping, University of Alaska; D. D'Amore, USFS; D.P. Franzmeier, Purdue; W.H. Hudnall, Louisiana State University; J.C. Bell, University of Minnesota; S.J. Hundley, USDA-NRCS; J.L. Richardson, North Dakota State University; J.H. Huddleston, Oregon State University; L.P. Wilding, Texas A&M; R.W. Griffin, Prairie View A&M University.

Objective: To collect factual data on wetness properties of soils over a long enough period to reflect current climatic fluctuations.

Summary: Projects funded for 10-12 years. Monitoring data collected on 225+ sites. All soils described and sampled for soil characterization analysis at the Soil Survey Laboratory. Several theses, papers, oral presentations, and posters prepared. Meeting in August 2001 to work on joint publications.

17. Anthropogenic Impacts on Soils

Principal Investigators: Joyce Scheyer and other NCSS cooperators. Contact: Joyce Scheyer, 402-437-5698, joyce.scheyer@nssc.nrcs.usda.gov.

Purpose: To develop resource materials on urban and anthropogenic soils as a basis for recommended changes in NCSS soil survey to include human-affected soils.

Project Description: (a) develop protocols for measuring human-influenced soil properties that lead to changes in soil genesis or behavior (such as highway construction

or fill soils); (b) evaluate existing soil to human manipulation of soils across landscapes (such as interrupted hydrology or phosphorus transport); (c) review classification systems from other nations and glean nomenclature and thresholds to use in expanding U.S. Soil Taxonomy (such as Reductosols as artificial urban wetlands); (d) compile a matrix of garden vegetables and potential accumulation of toxic metals for use in planning community gardens with limited-resource survey data for map-unit designs and changes in key soil attributes directly related urban residents.

Expected Results: (a) preliminary key for classifying human-affected soils in U.S. Soil Taxonomy; (b) recommended procedure for correlating human-affected (especially urban) soils; (c) minimum data set of soil properties and thresholds for selected urban and anthropogenic soil interpretations, with case studies from measured soil behavior; (d) matrix of vegetables by metals for publication such as a fact sheet or technical note.

18. Evaluation of Soil Properties and Interpretations in the Soil Survey Program

Principal Investigators: Joyce Scheyer and other NCSS cooperators. Contact: Joyce Scheyer, 402-437-5698, joyce.scheyer@nssc.nrcs.usda.gov.

Purpose: To improve soil characterization and interpretation in the soil survey program.

Project Description: (a) evaluate soil properties linked to the formation and identification of fragipans, argillic horizons, glauconitic soils, Vertisols, and soils in vertic subgroups; (b) develop guidelines for managing compacted layers under various land uses; explore Andic properties in cryic soils at high elevations and Spodic soils on coasts; update methods and clarify use of cation-exchange capacity (CEC activity groups).

Expected Results: Algorithms to estimate relationships among soil properties for groupings listed above. (a) Management guidelines suitable for newsletters or fact sheets prepared for technical review and implementation in the NCSS soil survey program; (b) issue papers documenting the recommended updates, including potential impact on the cost of both farmland protection and urban development; (c) recommend changes in U.S. Soil Taxonomy or data population to reflect improved understanding of soil properties and their interactions.

19. Predicting Soil Resistivity

Principal Investigator: E.C. Benham, USDA-NRCS. Contact: Ellis Benham, 402-437-5132, ellis.benham@nssc.nrcs.usda.gov.

Purpose: This project involves using soil component data and a limited set of soil resistivity data to predict resistivity over broad areas.

20. Field Estimated Plasticity and Stickiness to Improve Soil Erosivity Prediction

Principal Investigator: E.C. Benham, USDA-NRCS. Contact: Ellis Benham, 402-437-5132, ellis.benham@nssc.nrcs.usda.gov.

Purpose: Field estimated stickiness and plasticity are being used, along with other field-estimated parameters, to predict the WEPP K factor.

21. Expert System Techniques

Principal Investigator: E.C. Benham, USDA-NRCS. Contact: Ellis Benham, 402-437-5132, ellis.benham@nssc.nrcs.usda.gov.

Purpose: Determine the applicability/feasibility of using expert system techniques to enhance soil maps, generate interpretations, and estimate data.

Summary: Increasingly powerful computer hardware has permitted the development of more sophisticated expert system software at affordable prices. Soils are a very complex natural system, integrating many inputs as they develop the properties we observe. This complexity limited the utility of expert system software available in the past. Currently available software has not been evaluated in depth to see if it can provide information usable to solve real problems.

22. Automated Data Analysis from X-Ray Diffraction of Soil Clays

Principal Investigator: E.C. Benham, USDA-NRCS. Contact: Ellis Benham, 402-437-5132, ellis.benham@nssc.nrcs.usda.gov.

Purpose: To obtain additional mineralogical information for minerals with d(001) spacings greater than 0.7 nm. Patterns are being converted to a format that will allow the use of more sophisticated peak detection and deconvolution software.

Soil Climate

23. NRCS Soil Climate Team

Principal Investigators: Ron F. Paetzold, USDA-NRCS; state and local NRCS, other Federal agencies, universities, and state agencies. Contact: Ron Paetzold, 402-437-4133, ron.paetzold@nssc.nrcs.usda.gov.

Summary: The NRCS Soil Climate Team manages 16 separate long-term soil climate projects. We have more than 130 active stations in 33 states, Puerto Rico, the U.S. Virgin Islands, Antarctica, China, and Mongolia. Measurements include: soil temperature, soil water content, soil water potential, soil water level, soil redox potential, soil heat flux, air temperature, relative humidity, windspeed and wind direction, precipitation, total solar radiation, net radiation, IR radiation, barometric pressure, and snow. Not every station measures all of these variables, but each station monitors soil temperature and some form of soil water. The data from these stations are used for many purposes, including: testing and improving Soil Taxonomy, soil classification, NASIS, soil interpretations, drought definition, monitoring the severity and extent of droughts,

research, modeling, and global climate change. Users range from scientists and engineers to teachers and school children. Many of the projects are cooperative with state and local NRCS offices, other Federal agencies, universities, and state agencies. Data from many of the stations are available through the Internet on the NRCS National Water and Climate Center homepage. Eventually, all of the data will be posted there. Data from about one-third of the stations are downloaded daily through meteor burst telemetry or cell phones. Data from another third of the stations are downloaded manually on a monthly basis. The rest of the stations are in such remote areas that the data are downloaded annually. The stations are collecting more than 4,000 measurements per hour, or nearly 100,000 data points per day. This is more than 35 million measurements per year. Our chief needs are technicians and operating funds.

Soil Geomorphology

24. Development of Soil-Geomorphic Models

a. Geomorphic Models for Mountainous Terrain

Principal Investigators: C.G. Olson, N. Peterson, G. Hoffman, and B. Gardner, USDA-NRCS. Contact: Carolyn Olson, 402-437-5377, carolyn.olson@nssc.nrcs.usda.gov.

Purpose: To improve soil-geomorphic models for areas of high elevation and steep terrain. To develop consistent landscape terminology for steep terrain and alpine regions, in particular terms for landforms and positions on these landforms.

Summary: A series of sites was sampled in several landform positions. Depth of weathering and degree of soil development are being examined. Analysis will continue this year and into next fiscal year. Geomorphic processes active in steep mountainous terrain will be assessed and results compared with soils mapped in these areas. A procedure will need to be developed to assess depth to bedrock and attempt to separate residuum from colluvial deposits.

b. Soil-Geomorphic Model for Southern Illinois

Principal Investigators: C.G. Olson, W.D. Nettleton, D. Preloger, USDA-NRCS; and numerous other area and field office NRCS personnel in Illinois. Contact: Carolyn Olson, 402-437-5377, carolyn.olson@nssc.nrcs.usda.gov.

Purpose: To design and implement a working soil-geomorphic model for efficient soil survey mapping in south-central Illinois.

Summary: Soils were sampled in several counties in southern Illinois. A soil-geomorphic model was developed that provided support for adjusting some of the soil series concepts. In addition, evidence was uncovered for regional erosion surfaces that impact the Quaternary geology and paleoclimate history of the Midwest. Current plans are for analysis and publication of the material.

c. Soil-Geomorphic Model for Whitebreast Creek Watershed, Iowa

Principal Investigators: C.G. Olson, USDA-NRCS; T. Fenton, Iowa State University; A. Bettis, University of Iowa; L. Boeckmann and D. Oelmann, USDA-NRCS; and other local NRCS field office personnel. Contact: Carolyn Olson, 402-437-5377, carolyn.olson@nssc.nrcs.usda.gov.

Purpose: To understand the significance of unusually wide terraces adjacent to streams in south-central Iowa.

Summary: Deep cores were taken on geomorphic surfaces throughout the middle reaches of the Whitebreast Creek watershed in Lucas County, IA. The integration of the wide terraces into the Quaternary geomorphic history of the area is being investigated. A model for the presence of the terraces in relation to soil survey will be proposed.

25. MLRA 77-Southern High Plains Project

Principal Investigators: C.G. Olson, USDA-NRCS; B.L. Allen and students, Texas Tech; M. Ransom, Kansas State University; Curtis Monger, New Mexico State; D.A. Wysocki, D. Nettleton, G. Scott, J. Ford, and S. Horton, USDA-NRCS; other NRCS personnel in Kansas, Oklahoma, and Texas.

Purpose: To provide quality soil-geomorphic information for the MLRA 77 update in a sufficient detail for focused areas. To determine the sediment distribution of the near surface in a reconnaissance mode. To obtain data necessary to study past effects and predict future effects of climate change on soils and ecosystems. To make inferences from soil properties and stratigraphy as they relate to environmental concerns, such as ground-water recharge, surface water quality, and carbon sequestration.

Summary: Several reconnaissance transects have been completed. Presentations at professional meetings and publications have been completed. Holocene climate change in southwestern Kansas and Oklahoma is examined using carbon isotope data. Current work centers on establishing the boundary of the High Plains-Desert using carbon isotopic proxies and rare earth element distributions for climate change in New Mexico. Further analysis of sampled locations awaits laboratory analysis. Additionally, a graduate student completed field work near Big Spring, Texas, at the southern end of the High Plains, investigating soil genesis and climate change in the Lake Lomax basin. Deep drilling was begun last summer and is planned for the summer of 2001.

26. Soils and Geomorphic Evolution of the Macon Ridge

Principal Investigators: D.A. Wysocki and L.B. Ward, USDA-NRCS, and E.M. Rutledge, University of Arkansas. Contact: Douglas Wysocki, 402-437-4155, doug.wysocki@nssc.nrcs.usda.gov.

Objectives: (1) Evaluate the extent, thickness, and thinning pattern of loess or loesses on

the Macon Ridge; (2) Establish age and stratigraphic relationships of loesses and alluvium on the Macon Ridge; (3) Use age, stratigraphy, and thickness of loesses to define suites of map units and to refine map-unit concepts in the soil survey update of MLRA 131/134 and interpret geomorphic evolution of the southern Mississippi River terrace system; (4) Use loess age and stratigraphy to elucidate the geomorphic history of the Macon Ridge.

Summary: Braided outwash deposits underlying the Macon Ridge form a high-quality, high-yield aquifer utilized by agriculture, industry, and municipalities. Loess forms a relatively thin, surficial mantle that influences both the rate and quality of recharge water entering the coarser grained alluvium. Loess is a critically significant stratigraphic unit with respect to protection of the aquifer and as a parent material for soils. The Macon Ridge is interpreted as an early Wisconsin valley train of glacial origin. Age and number of loesses on this surface should be consistent, dependent upon distance from the source. Peoria loess occurs along the eastern side of the Macon Ridge in LA. Thick (> 10 m) to no loess cover occurs across the Western Lowlands. Loveland loess with a well-developed paleosol is present on terrace Pve3; the terrace is Illinoian age. Terrace levels in the Western Lowlands lower than Pve3 must be mid to late Wisconsinan in age. Do the same relationships exist on the Macon Ridge? Terrace level Pve3 is mapped as an element of the Macon Ridge. Does the Macon Ridge represent the same constructional surface or surfaces as the Western Lowlands?

27. Juniper Bay: Carolina Bay Formation and Wetland Restoration

Principal Investigators: M. Vepraskas and J. White, North Carolina State University; B. Zanner, University of Nebraska; D.W. Wysocki, USDA-NRCS. Contact: Doug Wysocki, 402-437-4155, doug.wysocki@nssc.nrcs.usda.gov.

Objectives: (1) Document the variability in the properties of soils and sediments and the water table regime across Juniper Bay and a reference bay that will affect restoration success; (2) determine current ground-water flow paths and the water table regime both inside and outside Juniper Bay and identify a strategy for hydrologic restoration; (3) test different restoration methodologies.

Summary: Carolina Bays are oval, closed depressions mainly on uplands in the Atlantic Coastal Plain. Bays are most numerous in North Carolina and South Carolina. They range from an acre to several hundred acres in size. Marine, fluvial, and eolian processes deposited sediments on the coastal plain. Consequently, stratigraphic units can consist of sands, silts, or clays in intricate patterns. Juniper Bay is a large bay in Robes County, North Carolina. Drill core to depths of meters will be made inside and outside the bay to establish stratigraphy and the control it has on the water table and water movement in the locality. The composition and, where possible, age of the stratigraphic unit will be determined.

28. Deep Investigations Topics

Principal Investigators: D.W. Wysocki, P.J. Schoeneberger, C.G. Olson, W.D. Nettleton, J. Doolittle, L. Steffen, B. Broderson, F. Young, USDA-NRCS; J. Richardson, North Dakota State University; H. LaGarry, Conservation Survey Division, Nebraska; J. Brown, Department of Natural Resources and Geology, Missouri State University; USGS personnel. Contact: Doug Wysocki, 402-437-4155, doug.wysocki@nssc.nrcs.usda.gov.

Background: Unconsolidated materials (regolith) and weathered bedrock below the soil solum (e.g., below 80 inches) commonly exhibit some degree of soil development and often exert a significant influence on soil behavior and land management practices above them. The type and arrangement of regolith materials (stratigraphy) and their properties determine the inherent water movement dynamics in the vadose zone (soil hydrology) and the interactions with materials that move with or are left behind by soil water (e.g., contaminant movement and attenuation). These materials strongly affect soil processes and subsequently determine soil morphology and geography. They are also a key component of ecosystem function at large. Soil scientists, particularly those involved in soil inventory, have not rigorously explored or documented deeper materials, even when observed. Geo-scientists have also minimized information about surficial deposits, especially pedo-stratigraphic phenomena (e.g., stacked paleosols in loess), resulting in an information gap between the two disciplines. The NRCS Deep Investigations program is charged with providing basic information on the behavior, distribution, and properties of materials below the documented soil zone and above coherent bedrock and with generating NCSS descriptive protocols for assessing these materials.

a. Description of Paleosols, Geologic Materials, and Weathering Zones

Deep Investigations Team: Identify pertinent descriptors and develop descriptive protocols for observing and documenting regolith below the solum and above hard rock.

Background: The focus of the NRCS Deep Investigations Team is on material behavior (properties), distribution, and the development of descriptive/inventory protocols.

Objectives: To extract and synthesize existing information to (a) determine and document the major types, properties, and distribution of regolith and weathered rock in landscapes across the U.S. in relation to soil survey; (b) develop appropriate descriptive protocols to enable meaningful documentation of these materials within the NCSS program; (c) conduct field studies to test appropriate models and descriptive protocols; (d) demonstrate how to incorporate this information into soil surveys and the NCSS program (assess available field-investigative technologies to determine appropriate use and limitations to users).

b. Description, Properties, and Distribution of Saprolite/Weathered Rock

Background: Roughly half of the continental U.S. has soils underlain by weathered rock that occurs within 1 meter of the ground surface. The availability and movement of water

through this underlying regolith are of primary importance affecting many soil interpretations, specifically those concerned with water quality, pollutant movement, and related environmental issues. Recent studies have shown that pedogenic processes are commonplace within saprolite and that these materials exhibit attributes of both soil and rock. This is a progressive series of related projects aimed at methods development and parameter measurement that will help us to understand the nature and properties of weathered rock and to determine their distribution (geographic occurrence). The projects include a specific focus on water movement through continua of soil, highly weathered transitional material (e.g., saprolite), and weathered rock. The approach includes basic research and practical applications.

Objectives: (a) Assess and explain the nature and rate of water movement through residual soil / saprolite / weathered rock continua for several different major rock types (to date: acid igneous and mafic igneous rocks, sandstone, siltstone, limestone; (b) Determine the influence of geomorphic position upon the hydraulic properties of soil and weathered rock.

29. Geomorphic Description of Land Areas

Principal Investigators: P.J. Schoeneberger, D.W. Wysocki, C.G. Olson, USDA-NRCS; J. Keyes and A. Rorick, USFS. Contact: Philip Schoeneberger, 402-437-4154, philip.schoeneberger@nssc.nrcs.usda.gov.

Glossary of Geomorphic and Geologic Terms: Development of Landform and Geologic Material Terms and Definitions

Geomorphic Description System: Development of Comprehensive System (arrangement) of Geomorphic/Soil Geomorphic Descriptors

Background: Landform descriptors and geomorphic concepts are cornerstones for understanding and communicating information about soil geography and processes. There has been a long-standing need for (a) a comprehensive glossary of geomorphic/soil geomorphic terms that presents standard terminology for use by the National Cooperative Soil Survey (i.e., Part 629—Glossary of Geologic Materials and Landforms, National Soil Survey Handbook; (b) a usable and scientifically credible arrangement of these terms in an organized system (i.e., Geomorphic Description System, or “GDS”) [both items have been adopted by the NRCS for national use and are integral parts of NASIS]; and (c) new geomorphic concepts and terminology for previously neglected areas (e.g., Flat Plains).

Objectives: (a) To compile, review, refine, organize, and evolve geomorphic descriptors used within the NCSS program; (b) coordinate the national use of standard terms and definitions within NRCS, among other Federal agencies, and NCSS cooperators; (c) develop new concepts and terminology for previously neglected areas (e.g., Geomorphic Components for Flat Plains).

30. Water Movement in Landscapes: Soil Hydrology

Principal Investigators: P.J. Schoeneberger, D.W. Wysocki, E.C. Benham, W.C. Lynn, J. Doolittle, USDA-NRCS; J. Richardson, North Dakota State University; J.C. Bell, University of Minnesota. Contact: Philip Schoeneberger, 402-437-4154, philip.schoeneberger@nssc.nrcs.usda.gov.

a. Soil Hydrology Team: Development of conceptual models of waterflow through landscapes.

b. Soil Hydrology Methods Development: Find/review/develop techniques to assess waterflow through landscapes, to determine and communicate appropriate use and limitations to users.

Background: Soil hydrology largely controls soil processes and determines soil morphology and subsequently soil geographic patterns. It is also a key aspect of ecosystem function, a primary pathway controlling terrestrial mass balances, contaminant movement, effective watershed management, water quality, and related wet soils issues.

Objectives: (a) Determine and document the scientific basis, phenomena, and conceptual models of water movement within soils and through soil landscapes across the USA. Emphasis is placed on understanding and identifying the dominant regional climatic control on soil hydrology and then detailing important variations due to parent material, texture, etc. within regions. (b) Conduct field studies to test appropriate conceptual models (e.g., Jennings and Jasper Counties, IN—Wet Soils Monitoring sites). (c) Demonstrate how to quantify and incorporate “When, how, and where” water moves through landscapes into soil surveys and the NCSS program, including the development of specific field-oriented methods (e.g., permeameters).

Charge 2: Identify opportunities for partnering on priority research needs

Developing contractual grant support from donor agencies, such as USDA, NSSA, NSF, EPA, USAID, USGS, AES, other Federal and state agencies, private sector, and foundations, is generally competitive. Potential for funding is enhanced when the proposed research project shows strong partnering among NCSS cooperators, diverse in expertise and broad in scope. To ensure diversity in the research cadre and institutions engaged, partnerships among scientists in the 1890 Colleges and Universities (Historically Black Colleges and Universities) and Minority Institutions (including American Indians and other minorities) should be enhanced and nurtured.

The NCSS needs to nurture traditional partnerships (e.g., Land Grant Universities, State Agencies, and NRCS) and develop new partnerships (Research Needs Committee Report, North-Central Region, Mickey Ransom, Chair). Identifying research priorities (e.g., MLRA boundaries and landform terms) that hold a common interest among NCSS cooperators provides opportunities for partnering among traditional partnerships, resulting in potential sharing of expertise and resources to accomplish the research

objectives. Developing new partnerships, such as the National Association of Consulting Soil Scientists, provides opportunities for data sharing. We also need to establish mechanisms to verify the quality and credibility of these data. NCSS data need to be produced using nationally accepted standards and procedures.

The Experiment Station cooperators and Federal agencies in the NCSS face many challenges, e.g., reduced or limited funding, increased demands for research products, and changing demands for kinds of research products. Forums whereby *Experiment Station cooperators and leaders of the NCSS can meet and coordinate regional activities, e.g., Western Coordination Committee-093 and its predecessor WRCC-30, provide opportunities for the Experiment Station personnel to be actively involved in the planning of NCSS activities and coordination of research to support NCSS programs* (Research Needs Committee Report, Western Region, Randal Southard, Chair). These kinds of forums provide opportunities to develop and facilitate partnering on priority research needs.

Charge 3: Identify opportunities for funding priority research needs

Participants at the 2000 regional conferences stated that the 1997 report adequately addressed many aspects this charge (precluding any outdated information), adding that state and local sources should be added to the list at the regional level and the list should include environmental groups, such as Ducks Unlimited, the Sierra Club, and Nature Conservancy. The 1997 report list potential funding sources as follows:

Hard-Money Sources—legislated funds

USDA-CSRS to Universities and Agricultural Experiment Stations (Land Grant Systems, Historical Black Colleges and Universities, and Minority Institutions)

USDA-NRCS Soil Survey Division Federal allocations

USDA-ARS-FS Federal allocations

USDA—Cooperative State Research Service

USDA—Cooperative State Research Service

Soft-Money Sources—contractual grants

Private foundations, consulting firms, and corporations

Federal agencies/departments other than USDA, including EPA, DOD, DOE, DOI (USGS, BLM, and National Park Service), EPA, NSF (LTER and Environmental Quality), and NSSA.

USDA-NRCS-Soil Survey Division REP#126-FW-NRCS-97, USDA-FAS-ICDRSE

(Foreign Agricultural Service, International Cooperation Developmental Research and Scientific Exchange Division), USDA-ARS (Conservation Reserve Program, Soil Erosion, and Climatic Change), USDA (Competitive Water Grants Program and National Research Initiative), USAID—Collaborative Research Support Programs, etc.

Charge 4: Increase the visibility and credibility of the NCSS

The NCSS is generally considered one of the most enduring (since 1899) and successful examples of cooperation and partnerships among Federal, State, and local units of government and the private sector ever undertaken. This success is in part due to the broad and diverse science-based activities of the NCSS. The collection, assimilation, and interpretation of sound scientific data, both field and laboratory, are the foundation of the NCSS and its research activities. Continued visibility and credibility of the NCSS require a strong research agenda that successfully addresses critical regional and national issues by transmitting complete, accurate, and understandable information (via scientific publications, presentations, soil survey investigation reports, CD-ROMs, maps, etc.) to the users of soil survey data.

Other important mechanisms by which to ensure continued NCSS visibility and credibility are education, marketing, and professional enhancement. Some examples of these mechanisms are as follows: (1) encourage professional licensing and certification of soil scientists; (2) encourage membership by soil scientists in professional organizations, e.g., ASA; (3) promote adding soil science to the curriculum of K-12 schools (examples of programs are GLOBE [developed by NASA] and Envirothon); and (4) add marketing issues to future state work-planning conferences and discuss how such issues can expand our product line; making use of the internet, CD, and electronic delivery; and developing educational displays in rest areas, schools, civic meeting locations, etc. (Committee 3, Research Needs, North-Central Region).

Charge 5: Ensure the technical excellence of the NCSS

Some participants at the regional conferences stated that the 1997 Standing Research Agenda Committee Report adequately addressed this charge, adding only that partnerships should be emphasized in our efforts to ensure technical excellence of the NCSS. The 1997 national report states:

If research of relevance to national priorities and the NCSS are conducted in a manner that meets scientific scrutiny and is reviewed within the scientific community, then the technical excellence within the program will be continuously upgraded. It is important that prioritized national research agenda:

Establish long-term monitoring that considers perturbations and dynamics in soil processes to facilitate a factual database for landscape units.

Enhance opportunities for employment of scientists within the NCSS at all levels of academic training, but especially to attract leaders with national and international scientific recognition.

Provide incentives for partnerships among the NCSS cooperators, especially those engaged in private-consulting professions; and

Provide incentives for scientific creativity, professionalism and excellence.

Charge 6: Identify an outstanding research project within the NCSS partnership to present at the NCSS conference

An outstanding research project within the NCSS partnership was selected and presented at the NCSS Conference (Fort Collins, Colorado, June 26, 2001) entitled “Soil Survey Needs, Partnering, Funding, and Visibility at the NSF-LTER Sites” by Indy Burke/Carol Yonker. Refer to this section of the Conference Proceedings.

Charge 7: The NCSS Research Agenda Standing Committee will be required to report its activities at each national conference

At the NCSS Conference in Baton Rouge, Louisiana (June 16-20, 1997), the Research Agenda Standing Committee met in a breakout session and later presented its report at the conference. This report was published in the 1997 NCSS Conference Proceedings. At the NCSS Conference in St. Louis, Missouri (June 27-July 2, 1999), no report by this committee was presented at the meeting or published in the proceedings. The report herein is part of the NCSS Conference Agenda and Proceedings (Ft. Collins, Colorado, June 25-29, 2001).

The collection and synthesis of ideas from NCSS cooperators on the four regional conference committees on research needs serve as the foundation for the national report. These regional reports capture the wide diversity in scope and priorities of research activities among partners in the NCSS program. The national report is primarily a consolidation of these four regional conference committee reports, serving as a focal point in providing useful information for the identification, prioritization, and allocation of resources to address the critical NCSS research activities/needs. We encourage the regional conference committees on research needs to meet and discuss these issues, which are very important to the NCSS.

Recommendations of the Committee

The committee recommended that one scientific question be stated that would encompass the major research needs of the NCSS. That question is as follows:

How does water move through soil at the landscape scale?

Within the context of this question, the committee recommended that the following topics be researched:

1. Surface water pollution
2. Subsurface (ground-water) pollution

3. Water limitations to native vegetation
4. Wetlands
5. Urban waterflow
6. Hydro-geomorphic mapping of watersheds

The committee also concluded that these topics should be researched with the following question attached to each:

How do the processes in these research topics affect sustainability?

Outstanding Research Project—Soil Survey Needs, Partnering, Funding, and Visibility at the NSF-LTER Sites

Gene Kelly, Caroline Yonker, Ingrid Burke, Colorado State University

Shortgrass Steppe Long-Term Ecological Research Program

Prior research at site:

- ✓ Location of the USDA-ARS Central Plains Experimental Range (since 1938)
- ✓ Location of International Biological Program Grassland Biome Project (1960s-70s)

SGS LTER funded in 1982

Focus: To understand the structure and function of shortgrass steppe ecosystems

Principal investigators and topics of study:

Ingrid Burke, PI, CSU, Forest Sci.: biogeochemistry
William Lauenroth, PI, Range Sci.: ecosystem ecology
Joy Bergelson, U. Chicago: plant population genetics
Debra Coffin, USDA-ARS: plant ecology
Jim Detling, CSU, Biology: plant ecology, grazing ecology
Gene Kelly, CSU, Soil/Crop Sci.: paleopedology, geochemistry
Daniel Milchunas, CSU, Range/NREL: grazing ecology
John Moore, UNC: soil food web dynamics
Arvin Mosier, USDA-ARS: trace gas flux
Bill Parton, CSU, Range/NREL: biogeochemistry, modeling
Roger Pielke, CSU, Atmos. Sci.: atmospheric science
Osvaldo Sala: Univ. Buenos Aires: ecosystem ecology
Bea Van Horne, CSU, Biology: mammal ecology

What makes LTER unique?

1. The nature of what we study
2. Long-term dynamics
3. Monitoring in addition to short-term experiments
4. We learn things that are likely more policy-relevant than short-term projects.
5. Highly interdisciplinary
6. Not just focused on one discipline or a few participating scientists
7. Our investment in data management
8. Our data should be available to future generations.
9. Future scientists need to understand where we studied, how we measured, and what are our results were.

10. Imagine how many records and how much effort we expend on data management!
11. We are part of a large network.
12. Scientists want to compare across ecosystems, so we must coordinate with other sites.
13. We spend a lot of time talking to other scientists about methods, results, and ways that we can cooperate.
14. Two meetings per year of the lead PI's; two meetings per year of the five scientists on the Network Executive Committee

Pedological investigations focus on paleoenvironmental reconstruction:

- ✓ What is the rate of climatically induced ecosystem changes, as determined through terrestrial proxy records (i.e., paleosols)?
- ✓ Are paleosols significant carbon “sinks” which may become “sources” if sand sheets are mobilized by changing climate?
- ✓ How has the biodiversity of the SGS changed through the Holocene as a function of climate and climatically driven changes in regional physiography?

Important questions relating to soils and soil-landscape relationships:

1. Which landforms cycle water most efficiently?
2. To what degree does landform structure control weathering vs. atmospheric inputs of nutrients?
3. How does landform diversity influence plant and animal community distributions?
4. How does the soil-landscape mosaic influence foraging behavior and species composition?
5. How does the soil-landscape mosaic influence water and nutrient distribution and primary production?
6. How does pedon morphology influence soil water/atmospheric water budgets?
7. What is the role of the individual plant in altering soil water/atmospheric water budgets?

Needs:

Soil data needs of the research scientist generally differ from those of other users ...
Data requirements are really a question of scale.

LTER scientists require:

1. Scale-appropriate soil maps
2. Larger scale than SSURGO
3. Compatibility with pasture- and plot-scale research requires order 2 with windows of order 1.
4. Soil data, as opposed to interpretive information or series descriptions

Partnering:

CSU

Gene Kelly
Caroline Yonker
Ingrid Burke

ARS

Gerald Anderson
John Hansen

NRCS

Klaus Flach
Carol Wettstein
Alan Price
Mike Petersen
Carolyn Olson

Funding:

Soil mapping
NRCS—Petersen
CSU—Kelly, Yonker, Blecker
Soil moisture and temperature data
CSU—LTER
Soil sampling and characterization
NSSL—Reinsch
Geomorphic investigation
NSSL—Olson
Digitizing
ARS—Hansen
Additional resources
CSU—Agricultural Experiment Station
Visibility

NSF Long-Term Ecological Research Program
ASA Soils-Geomorphology Tour

Standing Committee on NCSS Standards

Chair—Craig Ditzler, National Leader for Standards, NRCS, NSSC, Lincoln NE

The Standing Committee on NCSS Standards has not been active since 1995. I recommend that the conference steering committee update the charges and appoint new members.

Following is a summary of recent activity at the National Soil Survey Center relating to soil survey standards:

- **Use of the World Wide Web.**—We are increasingly using our Web site (<http://www.statlab.iastate.edu/soils/nssc/>) as a tool to communicate with all NCSS cooperators. For example, the NSSC Web site has a button for “standards for soil survey.” The link for the National Soil Survey Handbook contains buttons for “Recent Changes” as well as “Proposed Changes.” In the future we will be posting proposed changes to other documents containing standards (i.e., *Soil Taxonomy*, *Soil Survey Manual*, etc.) for comment.
- **Soil Survey Manual.**—The SSM was last printed in 1993. It has been out of print for some time now. We are beginning to develop plans to revise it. Some new features will include:
 - ✓ Discussion of investigative techniques for biological sampling, documenting dynamic soil properties, and using geophysical tools, such as electromagnetic induction and ground-penetrating radar.
 - ✓ New information pertaining to soil interpretations, such as fuzzy set theory, use of GIS for geospatial interpretive applications, and urban interpretations.
 - ✓ Data management.
- **Soil Taxonomy.**—Several proposed changes have been received by the Soil Classification and Standards Staff since the 2nd edition of *Soil Taxonomy* was published in 1999. These will be circulated to the Regional Taxonomy Committees (and posted to the Web) for review and comment.
- **Field Book for Describing Soils.**—A new edition is in edit now. Errors in the first edition are being corrected, and some new information is being added. The new edition will receive a limited distribution to NCSS cooperators and be available for purchase from GPO.
- **Munsell Soil Colors.**—A new page containing chips with olive and green colors has been developed (10Y and 5GY hues, values 3-6, and chromas 2 & 4).

Standing Committee on New Technology

Co-Chairs:

Pete Biggam, NPS, Lakewood, CO

Berman Hudson, NRCS, Lincoln, NE

Report to the National Cooperative Soil Survey Conference

Fort Collins, Colorado

June 25-29, 2001

Charges:

“To develop and document procedures, processes, and standards that will be used to integrate GIS, remote sensing, landscape modeling, and other similar technologies into the mainstream of the soil mapping and landscape inventory program.”

Committee Members:

Sheryl Kunickis, NRCS, NHQ

Bill Ypsilantis, BLM, CO

Darwin Newton, NRCS, TN

Roy Vick, NRCS, NC

A-Xing Zhu, Univ. of WI-Madison

David Howell, NRCS, CA

Bill Broderon, NRCS, UT

Activities:

1. Reviewed recommendations from the 1999 Report
2. Reviewed recommendations from 2000 Regional Conference Reports (input from the West Session)
3. Questionnaire sent out to all State Soil Scientists on capturing latest activities in regards to “new soil survey technology”
4. Identified an Outstanding New Technology transfer project within the NCSS partnership to present during this session

Results:

1. Committee agreed with the recommendations of the previous committee but realized that several are still impacted by funding and/or personnel issues which need the attention of a higher level. However, several states have added GIS support staff at state and project office locations.
2. Committee was involved in developing a cooperative agreement with University of Wisconsin-Madison to evaluate the SoLIM procedure at Great Smoky Mountains NP.
3. This would not only focus on the application for mapping purposes, but also allow for technology transfer of software, databases, etc. to allow for future use in other applications.
4. Questionnaire sent out to State Soil Scientists attempted to clarify “new technology” as “new” techniques, innovations, procedures, applications, or concepts that assist in the activities of a soil survey.
5. Intended to be the start of a database which would identify “new technologies” and track their progress.
6. Received only nine responses (so we know we need to follow up).

Findings:

Information that relates to new technology development, application, and utilization is not sufficiently disseminated within the NCSS, nor is it tracked or readily available for review within systems currently in place.

Recommendations:

1. Develop a method to facilitate documenting what types of new technology are currently being utilized within the NCSS, as well as those which might have just recently been completed.
2. Consider addressing “New Technologies” within the site navigation of the National Soil Survey Center’s Homepage, as well as expanding the current “NSSC Discussion Forums” section to include a “New Technologies and Soil Survey Forum” section.
3. Continue to follow up on the previously identified recommendations from the 1999 NCSS New Technology Report.

Outstanding New Technology—The Use and Application of SoLIM (Soil Landscape Inference Model) in Project Soil Surveys

Sheryl H. Kunickis, Ph.D., NRCS, Washington, D.C.

Historically, the soil scientist’s mental model of how, when, why, and where soils occur on a landscape in a particular location is lost when he or she transfers or retires. This is particularly a sensitive and timely issue as over 50 percent of the soil survey workforce is eligible to retire within the next few years, resulting in a tremendous loss of information that has been acquired through years of study and observation. In addition, there is not a base of qualified and available soil scientists to fill these positions. SoLIM essentially transfers this carefully developed mental model to a knowledge base that can be stored, improved, and used at any time.

The current method of mapping soils involves stereoscopic use and time-consuming manual cartographic work that introduces unintentional errors, depending on the soil scientist’s proficiency in these methods. Unfortunately, the science may be lost in the cartographic process. SoLIM replaces these somewhat antiquated and laborious practices through the use of modern GIS procedures and an automated inference scheme.

Traditionally produced soil maps use polygons to delineate soils with the understanding that there are inclusions of similar or dissimilar soils that are not named in the label. The inclusions are not mapped separately, generally because of the scale that is used. Inclusions are inherently understood by soil scientists but are not always understood by the user. As a result, the soil map is considered “wrong” if a soil other than the named soil is found within the polygon. Assuming that the source data is accurate, SoLIM-produced maps distinguish understated variation in environmental conditions and landscape differences that cannot be shown using traditional mapping techniques.

Accuracy

When field checked, SoLIM-derived soil maps exhibit a better quality than conventional

soil maps. For example, field sites investigated by soil scientists confirmed that maps produced using SoLIM correctly identified over 80 percent of the soil series at these sites, while conventional maps correctly identified 60 percent to 70 percent. Differences between the two maps, referred to as mismatches, showed that the SoLIM-derived map was correct 71 percent of the time, compared to 17 percent for the conventional map when examined in the field by a soil scientist.

Software (<http://solim.geography.wisc.edu/solim/software/3dMapper/3dMapper.html>), such as the 3dMapper, which facilitates landscape visualization and mapping in three dimensions, is used in the SoLIM process. It permits users to superimpose topography with GIS data layers to accurately identify landscape-related features and affords the user the ability to draw lines and polygons. Using 3dMapper, scientists can examine conventional soil maps in a digital format for line placement, slope verification, and various other items. This feature is particularly important as many of the users of digital soil maps have access to DEMs and other software and therefore have the ability to check the accuracy of our maps.

Some of the SoLIM products include fuzzy membership maps, detailed raster soil maps, and conventional soil polygon-like maps.

A fuzzy inference engine is used to determine the similarity vector for the soil at each pixel position. As a result, fuzzy membership maps can be produced to exhibit the spatial gradation of soils. Because of limitations in producing conventional soil maps, known transition areas between polygons are recognized as inclusions in the map unit. Soil interpretations do not account for these areas. Fuzzy membership maps identify and recognize the intermediate nature of soils and provide for better interpretations.

Soil bodies on a detailed raster soil map may be as small as one pixel, which translates to a more detailed soil map compared to a conventional soil map, which may be limited by scale. In addition, uncertainty maps can be produced using fuzzy memberships to validate decisions made on naming local soils.

Conventional soil polygon maps can be produced by “hardening” soil similarity vectors. Just as traditionally made soil maps have inclusions of unnamed soils within the polygon, so do SoLIM polygon maps. However, the composition of *each* individual polygon can be identified and described in detail, providing a more accurate and useful map.

Benefits of SoLIM

SoLIM is a tool that assists in producing more accurate and higher quality soil maps. It is not a system that replaces the soil scientist. Instead, it uses the soil scientist’s extensive knowledge of the soils in a particular area, combines it with the appropriate DEMs and key environmental information that determine conditions where soils form, and applies the fuzzy inference engine to produce an “inferred” map. Soil scientists verify the map. Discrepancies do not indicate problems with SoLIM but reflect areas where the soil scientist’s concept of the soil model has not been fully captured and needs to be refined.

The ability to revise and improve the model as the soil scientist increases his or her knowledge of the soil model allows for an immediate update of the soil map.

The magnitude of time and funds required to produce conventional soil maps is not practical in an era when products are in urgent demand, budgets are lean, and the soil science workforce is dwindling. SoLIM affords soil scientists the ability to quickly produce an accurate detailed soil map in areas where their knowledgebase is extensive, providing time for investigating complex landscapes where soil concepts and relationships are unclear. In addition, removing the manual cartographic work that inundates so much of the mapping procedure permits the soil scientist to spend more time in the field.

Soil maps produced with SoLIM are in a digital format. Cartographic processes, such as map compilation and digitizing, involved in preparing current soil maps are eliminated. This results in savings of time and money in producing a soil survey.

Current Projects

SoLIM has been developed by scientists at the University of Wisconsin at Madison, in a partnership with the NRCS Soil Survey Division, to assist in producing more accurate and higher quality soil maps. Initial studies in Wisconsin show that SoLIM-derived soil maps exhibit a better quality map when compared to a conventional soil map. Recent continued success in Wisconsin in using SoLIM can be attributed to the excellent relationship between the field soil scientists and university staff involved in this project.

In July 2001, the NRCS Soil Survey Division, the National Park Service, and the University of Wisconsin will pilot a 2-year project in the Great Smoky Mountains National Forest using SoLIM. During the first year, the SoLIM approach will be applied to produce a soil map in an area that was recently mapped by soil scientists in Tennessee and North Carolina, using the knowledge they have of soil-landscape relationships. In the second year of the project, information developed by the SoLIM approach will be used to map an adjacent area where there is no current soil survey information. The results will be the basis of assessing the adoption of these techniques for mapping soils in areas that are not easily accessible, as well as evaluating the use of the SoLIM model to produce soil maps.

Note:

This work is being carried out by Dr. A-Xing Zhu (axing@geography.wisc.edu) and Dr. Jim Burt (jburt@geography.wisc.edu) at the University of Wisconsin at Madison in cooperation with the Natural Resources Conservation Service. Details are available at the project Web site (<http://solim.geography.wisc.edu/>).

2001 Conference Committee 1—Selling Soil Science to Society

Report coordinated by Co-Chair Gary Muckel, National Soil Survey Center

Charge 1: Review the 1999 marketing committee report and 2000 regional conference reports with similar charges. Determine progress of recommendations from these meetings.

Charge 2: What soil survey products do users need/want, and how do they want them delivered?

Charge 3: How do we deliver products on time and on budget?

Charge 4: Develop a market strategy to sell soil science to society.

Charge 5: Market evaluation analysis for soil survey.

Charge 6: Coordinate a task force to study the feasibility of creating an Internet soils library.

Charge 1: Review the 1999 marketing committee report and 2000 regional conference reports with similar charges. Determine progress of recommendations from these meetings.

South Region.—Identify and develop strategies as methods to be used to increase the visibility of soil resources and the use of soil resource inventory products. They suggested:

1. Fund a co-op student in marketing to develop a marketing package.
2. Contract with a media firm to develop an information campaign.
3. No regional action to identify products to deliver soil resource information into the future. Suggested to elevate to national level.

North-Central Region.—Increase the visibility and credibility of the NCSS.

Recommendations:

1. Continue to push for professional licensing and certification of soil scientists.
2. Promote adding soil science to the curriculum in the K–12 schools.
3. Add a discussion of the marketing issue to each of the state work-planning conferences in the future, if this has not already been done.

1999 NCSS Committee Report on Selling Soils to Society.—The centennial provided a foundation in marketing with three targeted groups: Educators, land users, and decision-makers. The panels are still in use. Educators have been the focus for 2001. The others are part of yearly strategies.

- ✓ Establish a clearinghouse of information and products. The NSSC, as the location for the Web sites, is essentially the clearinghouse. Many products have been created since 1999 for use with marketing. Marketing responsibilities have been assigned.
- ✓ Market soil survey to NRCS personnel and managers. Soil data viewer and NASIS downloads to field office technical guides are opening this door. Marketing is included in training for resource soil scientists who primarily serve field offices. FY focus area is oriented towards this audience.
- ✓ Use, certification, registration, and licensing. Have each State Soil Scientist

- ✓ register. The Director of the Soil Survey Division has encouraged each State Soil Scientist to become ARCPACS registered.
- ✓ Customize soil survey products to individual user groups. Report and interpretation options allow state offices to perform this exact function.
- ✓ Provide support materials, such as canned speeches with scripts and talking points, for soil ambassadors. Material is being developed in the NSSC and placed on the Web or in brochures. More is needed. The centennial provided materials for public affairs people.
- ✓ Expand diversity. 1890 schools, Indian colleges, Hispanic colleges, and their representatives have been added to the cooperators in the NCSS. Recruitment at MANROS (Minorities in Agriculture) and at other group meetings has increased.
- ✓ Network with other professionals, especially engineers, hydrologists, crop tces o

2001 National Cooperative Soil Survey Conference

Environmental Justice Report

Preferred methods of being contacted: Television, newsletter, radio, printed material

Lowest preference: Compact disk, conservation fair, on-farm demonstration

Identified soil survey as NRCS's most identifiable service

Want soil survey as a laminated book in community centers of low income and rural communities

NRCS Customer Service Interview

1.

Charge 3: How do we deliver products on time and on budget?

- ✓ Be flexible when responding to customer needs.
- ✓ Do not be concerned with GPO-produced product. Information is needed, not a publication. Change publication mindset to an adjustable product.
- ✓ Partner with the private sector.
- ✓ Create a dedicated entity at the NSSC to determine customer needs.
- ✓ Invest in providing maps on-line. New tools and maps are wanted!
- ✓ Look for additional partners to hire soil scientists.
- ✓ Be sure that soil survey is relevant for a variety of scales and purposes.
- ✓ Provide accountability of NCSS by putting resources with commitments.

Charge 4: Develop a market strategy to sell soil science to society.

Current or Apparent Marketing Strategies (Emphasis for 2001 and Near Future)

- ✓ Develop soil survey text, tables, and maps in electronic format to allow for a variety of output products by NRCS or anyone else.
- ✓ Support NRCS field offices and other customers with Soil Data Viewer from data in NASIS and SSURGO.
- ✓ Develop Web-based applications for delivering soil data and products.
- ✓ Accelerate mapping in urban and urban fringe areas and develop urban interpretations.
- ✓ Accelerate mapping on Indian lands.

Proposed Marketing Strategies

Select goals and targeted messages for the next few-years. National focus to activate local action.

Approved are:

- 2001—Incorporate soils into natural resource education. Target: Science teachers
- 2002—Improved soil management. Target: Land managers and consultants
- 2003—Reduced loss of life and property. Target: Land use planners and contractors
- 2004—Understanding and protecting wild lands. Target: Wild land managers

Other strategies

- ✓ Prepare a list of current contacts with customer groups.
- ✓ Identify groups for focused marketing. Develop cadre of NCSS liaisons.
- ✓ Coordinate and encourage the efforts of agencies that are members of the NCSS, including the private sector.
- ✓ Encourage all soil scientists to look beyond their immediate profession and become team players with other allied professionals.
- ✓ Encourage soil scientists that map or work in the field to involve and educate more permanent professionals from Cooperative Extension, NRCS, FFA, vocational agriculture and science teachers, realtors, and other soil survey users about the soil information that they are producing.
- ✓ Build on the soils-related educational modules existing on the Web pages. Design

modules for primary and high school science and agriculture teachers as classroom exercises.

- ✓ Recognize that the strength of soil survey is the ability to deliver geographical information, not just data
- ✓ Make marketing an integral part of the soil survey program with a budget.
- ✓ Involve marketing specialists from all agencies in the NCSS.
- ✓ Partner with user groups to assist in marketing.
- ✓ Prepare press releases and align with environmental writers.
- ✓ Provide professional assistance to other disciplines.
- ✓ Demand use of taxonomy and other standards of soil survey.
- ✓ Illustrate soil genesis concepts in lay terms.
- ✓ Use local community groups (Landcare example) to raise environmental issues—watersheds, conservation districts.
- ✓ Use land judging, Envirothons.
- ✓ Retrain extension, district employees, and others who contact users.
- ✓ Provide support to project offices in marketing.
- ✓ Market availability of optional local interpretations.
- ✓ Develop benefit/cost ratios.
- ✓ Establish annual target messages and target groups.

Marketing is the art and science of selling ideas, goods, and services. Any marketing strategy should be totally focused on the customer. The organization exists for its customers. The needs, wants, values, and perceptions of the customers need to be thoroughly understood and should be the basis for action.

Product. —The organization makes products and services that people want.

Place. —The products are available when and where they are wanted.

Promotion. —Promotion puts issues on the agenda, promotes the product, and addresses barriers to use of the product

Charge 5: Market evaluation analysis for soil survey.

This charge was dropped for 2001.

Charge 6: Coordinate a task force to study the feasibility of creating an Internet soils library.

1. The concept is good, and in principle it is doable. However, there is concern that the cost and infrastructure could be overwhelming.
2. Software is available for such a venture. The NRCS photo gallery may be an example to follow (<http://photogallery.nrcs.usda.gov/>). This proposal would maintain the system from a central point.
3. Another approach would be a Web-based "Soil and Land Clearinghouse." With clear objectives and structure, management would set the pace using the resources under their control. Other participants then would be encouraged to follow a similar format and link to the main clearinghouse site. Thus, the satellite sites can dot the world, and each satellite is the responsibility of the owner who guarantees the contents. Other kinds of innovations could be included. A special section on banana soils, for

example, would accept contributions from everyone and the banana soil section will reside on the clearinghouse site with links to other sites.

4. The host of the site would not have to be NRCS. SSSA or others should be considered.

2001 Conference Committee 2—Training for Pedology with Landscape Analysis

Co-Chairs:

Wayne H. Hudnall, LSU, Baton Rouge, LA

Earl Lockridge, NRCS, NCSS, Lincoln, NE

Vision for the future

1. The farmers and ranchers produce more than grain and livestock.
2. That local action—neighbors working together—is the most promising foundation for effective land stewardship.

Vision

A productive nation in harmony with a quality environment.

(A nation where use of natural resources is governed by a widely shared and deeply felt stewardship ethic.)

Mission

1. Provide leadership and administer programs to help people conserve, improve, and sustain our natural resources and environment.
2. Help land users plan and apply integrated resource management systems that are economically and environmentally sustainable and meet mandated requirements.
3. Help public officials develop sound policies and plans for natural resource development and protection.
4. Try to lead people to a greater understanding of the world around them—of the physical and biological processes that shape it, of the ways their activities affect it, and of the responsibility all Americans share to work together to protect it.

National initiatives

1. Anticipate key natural resource issues and propose effective policies to address them.
2. Encourage voluntary solutions to natural resource problems. Fairly and efficiently administer regulatory roles legislated or delegated to the agency.
3. Provide comprehensive assistance to customers for the integrated management needed to sustain natural resources.
4. Promote the efficient management of water and the enhancement of its quality.
5. Maintain a highly skilled, diverse workforce capable of providing quality, customer-oriented service.

Philosophy

Education is the real key to permanent, voluntary conservation.

Introduction

- No curriculum addresses the needs of NRCS.
- Many NRCS personnel are eligible for retirement, and there are few replacements.
- Much of the conservation planning in the future will be completed by third party vendors.
- There are few third party vendors who are qualified and certified.

This committee should review standard university curricula for soil scientists and evaluate how soil scientists will gain field mapping experience.

With an emphasis on Taxonomy in Pedology, are there sufficient outlets for future soil scientists to develop skills in landscape analysis, geomorphology, GIS, and computer technology. Who will train the soil scientists of the future? What kind of opportunities will there be for developing new partnerships for training?

Charges

1. Who will train future scientists and how? (Consider classroom and field training.)
2. Review standard university curricula for soil scientists and evaluate how new soil scientists will get field-mapping experience.
3. Are there sufficient outlets for future soil scientists to develop skills in landscape analysis, GIS, geomorphology, and computer technology?
4. What kind of training is needed for soil scientists in basic soil science and in soil survey?
5. What opportunities will there be to develop new partnerships for training?
6. What are some training recommendations that will enhance skills in GIS and spatial statistics in soil survey?
7. Coordinate and review products from 2001 **Task Force 1: Soil Landscape Analysis Training Based Upon Soil Geomorphic Field Projects.**

Methods

1. An e-mail survey was sent to Land Grant and 1890 Universities with a list of questions from the charges asking what courses and curricula were being taught in soil science. Specifically, if they taught a field-mapping course. We received 22 responses.
2. We had an excellent discussion with the university representatives and other interested participants Tuesday morning.

Findings and Recommendations

1. Who will train future scientists and how? (Consider classroom and field training).
Universities will continue to train students in the basic sciences.

2. Review standard university curricula for soil scientists and evaluate how new soil scientists will get field-mapping experience.

Only a few universities have the staff and time to conduct a field-mapping course. The collegiate soil competition is probably the best field training a student can receive, but that is not field mapping.

3. Are there sufficient outlets for future soil scientists to develop skills in landscape analysis, GIS, geomorphology, and computer technology?

Many, if not most, land grant universities offer these courses. The courses generally are not offered in agronomy or soil science departments, but some departments do offer some of these courses. Students must be advised that such courses are offered by the other departments and encouraged to enroll.

4. What kind of training is needed for soil scientists in basic soil science and in soil survey?

We need soil scientists who can recognize and evaluate the inherent relationships that exist between soil, vegetation, climate, and landscapes (geomorphology, landform, geology, etc.)

5. What opportunities will there be to develop new partnerships for training?

Private consultants and environmental consulting firms that have mapping contracts or other contracts related to soil science should be utilized where possible. The training could be in relationship to intern programs or other employment opportunities. The NRCS student trainee program is highly recommended. Students cannot be expected to fund the cost of field map training.

6. What are some training recommendations that will enhance skills in GIS and spatial statistics in soil survey?

Students must be advised to take such courses. Evaluators of soil science position applications must recognize these courses as soil science courses. Evaluations should be completed within the state for which the vacancy is advertised.

7. Coordinate and review products from 2001 **Task Force 1: Soil landscape Analysis Training Based Upon Soil Geomorphic Field Projects.**

See report of Task Force 1. We agree with the concept, and the training should be provided by NRCS alone or by NRCS in cooperation with a university.

2001 Conference Committee 3—Training For Use and Applications of Soil Survey

Charge 1: What kind of training is needed for soil scientists in basic soil science and in applications of soil survey?

Foundation knowledge:

- Principles and theory of soil science
- Landforms and geology
- Mapping skills
- Knowledge of related disciplines
- GIS and GPS at awareness level
- Computer and database use and management knowledge

Soil survey interpretation products:

- Problem analysis and design of interpretations
- Populating the interpretation-supporting database
- Knowledge of NASIS or other interpretation platforms and interfaces
- Data collection for population of the database
- Soil survey product delivery (GIS & information technology)
- Evaluating and updating soil surveys
- Maintenance of soil surveys
 - Soil-plant interrelationships and ecological sites (state-transition model, etc.)

Direct client contact and service:

- Using a soil survey while working with a client
- Site-specific data collection and interpretation
- Data collection equipment and methodology
- Hydric soil/wetland data collection
- Designing effective GIS themes for the client
- Soil-related aspects of precision farming
- Soil quality and use-dependent property databases
- Remote sensing and photography
- Land use laws and regulations
- Differences between interpretation guidelines and local regulations
- Selling soil science/surveys and consulting
 - Communication and people skills

Charge 2: Review standard university curricula for soil scientists and evaluate how new soil scientists will get training for use and applications of soil surveys.

Foundation knowledge:

- Foundation skills (basic soil science, geomorphology, landscape analysis, etc.) have been and should continue to be addressed by the universities.

- University training should provide knowledge of GIS and other presentation/evaluation technologies at the awareness level. Because of ongoing change in information technology, it is not realistic to expect the universities to prepare students so that information technology skills precisely match current systems of the NRCS and other NCSS organizations. Students should have acquired computer-related skills, including use of databases.
- GIS is and will be a very important skill, and students should get their first exposure at the university.
- Over the course of a career, a soil scientist could potentially need to acquire some extent of knowledge in each of a leng

Soil survey interpretation products for general use:

- The committee observed that universities are already providing training in the skills needed to develop interpretation products intended for general use.
- Universities do not need to provide exposure to NASIS. Knowledge of NASIS should be provided by other sources of training.

Direct client contact and service:

- Universities have been and should provide training in the topics in the 'Direct Client Contact' category, except for land use laws and regulations and possibly soil quality tests.
- Universities should provide training in selling soil science and soil surveys and the "business" aspects of working with internal and external clients. These topics, as well as GIS, can be included in the curricula by means of multidepartmental cooperation and approach. Topics should include how to deal with the public, networking, etc.
- When explaining soil survey information, soil scientists need to use terms that others can understand. Soil scientist students should be sensitive to the potential for miscommunication or lack of communication. This is a topic that can be included with the training identified in the preceding paragraph.
- College sophomores and even younger students should be provided information on Civil Service requirements of a soil surveyor and encouraged to consider a career in soil survey and soil science. This early contact and awareness may increase our ability to recruit the graduate.
- Maxine suggested that a list of deans across the country be obtained. The deans would be targeted when we contact the universities to relay the training-related suggestions of this conference.

Charge 3: What are training recommendations to enhance or update skills for public and private sector soil scientists? Are there outlets that could provide for needed training that are accessible?

- Private firms in one state represented on the committee would be willing to pay for NRCS training.
- Due to a lack of time, the committee did not finish discussion on how to include the private sector in public sector training or vice versa. The sense of the limited discussion is that training activities can and should encompass both sectors wherever possible.

- University training can include full courses, institutes, and correspondence courses.
- Methods of post-university training identified by a few members of the committee in communication prior to the conference include organizational or multiorganizational courses, working on a short-term basis under an experienced person of the same or other organization, Web-based courses, courses and other forms of training offered by professional organizations that include both public and private sector members, on-the-job training, and self-directed training and study. Workshops, conferences, seminars, and tours may be sufficient to meet some training needs.
- Professional organizations might provide training via the Web, through certification programs, journals, workshops and seminars, and videos.

Charge 4: Is there a national strategy for data collection and interpretation with the public at large?

- The committee decided to drop consideration of this charge because it does not apply to training and also because of shortage of time. Also, the intent of the charge is not clear.

Summary of Findings

The committee did not complete discussion of post-university training sources and methods in the available time at the conference. The subjects that the universities can provide training in were thoroughly discussed. Assignment of post-university training methods to training subjects in the following summary is based on the input of a limited number of committee members prior to the conference.

| Summary of Training Topics and Methods | | | | | | | | |
|--|------------|-------|--------------------------------|---------------------|-----|----------|-----|---------------|
| Suggested Training Sources ¹ | | | | | | | | |
| | University | | Subsequent Training | | | | | |
| | Initial | Later | Org. or Multior. Courses, etc. | Exper. With Trainer | Web | Prof Org | OJT | Self Directed |
| <i>Foundation knowledge:</i> | | | | | | | | |
| Principles and theory of soil science | X | X | | | X | | X | X |
| Landforms and geology | X | X | X | | | | X | |
| Mapping skills | X | | X | X | | | X | |
| Knowledge of related disciplines ² | X | X | | X | | | X | X |
| GIS and GPS at awareness level | X | X | X | | | X | X | |
| Computer and database knowledge | X | X | | | | | X | |
| | | | | | | | | |
| <i>Soil survey interpretation products:</i> | | | | | | | | |
| Problem analysis and design of interpretations | X | | X | | | | X | X |
| Populating the interpretation-supporting database | X | | X | | | | X | X |
| Knowledge of NASIS or other interpretation databases and platforms | | | X | | | | X | X |
| Data collection for population of the database | X | | X | | | | X | |
| Soil survey product delivery (GIS & information technology) | X | | X | X | | | X | X |
| Evaluating and updating soil surveys | | | X | X | | | X | |
| Maintenance of soil surveys | | | X | X | | | | |
| Soil-plant interrelationships, S-T Models | | | | X | | | | |

| Suggested Training Sources ¹ | | | | | | | | |
|---|------------|-------|--------------------------------|---------------------|-----|----------|-----|---------------|
| | University | | Subsequent Training | | | | | |
| | Initial | Later | Org. or Multiorg Courses, etc. | Exper. With Trainer | Web | Prof Org | OJT | Self Directed |
| <i>Direct client contact and service:</i> | | | | | | | | |
| Using soil survey when working with clients | X | | X | X | | X | X | |
| Site-specific data collection and interpretation | X | | X | X | | X | X | |
| Data collection equipment and methodology | X | | X | X | | X | X | X |
| Hydric soils and wetlands | X | | X | X | X | X | X | |
| Designing effective GIS themes for the client | X | | X | | | X | | |
| Soil-related aspects of precision farming | X | | X | X | | X | X | |
| Soil quality and use-dependent property databases | | | X | X | X | X | X | X |
| Remote sensing and photography | X | | X | X | | | X | |
| Land use laws and regulation | | | | X | | X | | X |
| Interpretation guideline/local regulation differences | | | | X | | X | | X |
| Selling soil science/surveys and consulting | X | X | X | X | | X | | |
| Communication and people skills | X | | X | | | | | |

¹ Some training methods and sources identified by the committee are as follows:

University

- Full courses
- Short courses, institutes
- Correspondence

Cooperative NRCS-University field-based soil mapping course

Organization/multiorganization forums of private and government sectors

- Formal courses
- Workshops
- Projects and training events
- Tours, conferences, and seminars
- Team approach to data collection for soil surveys (might include private and public sector cooperators in data collection when soil surveys are updated)

Web based

Working briefly with mentors/coaches of same or different organization

Professional organizations

- Training, including Web based
- Certification
- Journals
- Workshops and seminars
- Videos

Supervisor-assigned and guided study and practice (on-the-job training)

Self-directed study and research

² Related disciplines identified by the committee include crop production, plant nutrition, irrigation water management, wastewater management, hydrology, erosion and sediment control, forest and range management, engineering, outdoor recreation, urban soils, mined land reclamation, agricultural economics, watershed management, precision agriculture, wetlands, and water quality.

2001 Conference Committee 4—Recruitment and Retention of Soil Scientists in Soil Survey

Co-Chairs:

Bob McLeese, NRCS, IL

Richard W. Griffin, Prairie View A&M, TX

Committee members: 21 individuals from 11 states and 10 entities

Charge 1: Investigate incentives and programs available to the NCSS to recruit soil scientists with assistance from the Office of Personnel Management (OPM) for the Federal Government.

Incentives available now

Relocation allowances for entry-level employees

- A) Recruitment bonuses—up to 25 percent of salary, approved at national level. State Conservationists can use up to 10-15 percent from their state funds. At present, NRCS is suggesting less than the OPM-approved guidelines. Keeping soil scientists for 3 years (or to the GS-9 level) greatly increases the chance of employees remaining with the agencies. Suggestions were offered that State Conservationists be allowed to use up to the 25 percent salary bonus level. According to current OPM statistics: 1) There are currently 1,750 eligible candidates on the soil conservationist (GS-0457) inventory, and 2) there are approximately 500 people on the soil scientist (GS-0470) inventory. A suggestion was made to negotiate a service agreement (such as a 3-year commitment) with recruitment bonuses. We must look at private sector incentives and strive to match or compete at a competitive level. Information from NRCS Human Resources Management, obtained by Ginger McGill, indicated approval of the 25 percent level with justification letters and quick turnaround being encouraged as part of agency commitment to recruitment and retention.
- B) Retention bonuses—up to 25 percent of salary. Discussion focused on: 1) Shortening the eligibility listing; 2) RECRUIT NEW EMPLOYEES AND RETAIN CURRENT EMPLOYEES; 3) 40 percent of previous salary is actual money available at retirement age; 4) Encourage staff to stay on at current positions; 5) Major “brain drain” in USDA in next 5 years; 6) Retention bonuses available for any employee; 7) Entry-level numbers are good, but retaining new employees is the major issue; 8) Retirement and return of current employees as consultants or temporary employees; and 9) “Begging” current employees to stay on for another year or two.
- C) Student loan repayment program—up to \$6000/year and up to a maximum of \$40,000. Information from NRCS Human Resources Management, obtained by Ginger McGill, indicated that no

departmental guidance from USDA is presently available. Also, a pilot made for this program is in place for Information Technology and Administration. Additionally, hiring below the GS-9 level without competition may be in conflict with the Leuvano consent decree for administrative positions; however, **THIS IS NOT AN ISSUE FOR PROFESSIONAL POSITIONS, SUCH AS SOIL SCIENTIST AND SOIL CONSERVATIONIST.** Finally, NRCS is waiting on the USDA to make a decision on this particular item.

- D) Additional incentives—Career Intern Program and Student Employment Programs available from the Federal Government based on noncompetitive appointments. Students can sign up for the Career Intern Program long before graduation. Discussion focused on: 1) Recruiting in November and December before summer employment applications; 2) Career Intern Program and Student Employment Programs can be used in combination, thus securing candidates when they are freshman and sophomores; 3) Meeting minimum qualification requirements upon graduation is the only requirement; 4) Marketing of philosophy of soils toward high school students as potential career option; 5) Elementary and 5th grade recruiting is not too early; 6) new, fresh marketing materials must be made available; 7) NRCS employees have linked with the GLOBE program; 8) Grade and pay banding will most likely not be available to the general agency populations of the Federal Government (except through demonstration programs) for 5 years.

Charge 2: What are the reasons that students do not apply for Federal jobs when they are made available?

Discussion focused on: 1) Students may not know about job listings; 2) Students have a preconceived idea that the Federal Government is a big bureaucracy that requires a long waiting period before hiring (this is often because agencies may recruit but then not have any vacancies to fill); 3) Lack of vacancy announcements for entry-level positions; 4) Salaries compared to those of the private sector; 5) Pay scale for soil scientists in the 470 series must be placed in a special salary rate; 6) Flexibility to stay in selected areas with additional experiences gained from details and other agency structured initiatives; 7) Employees given choice of work sites and better inputs on site movement patterns as well as timing; 8) Career days should be attended with focused message based on occupations available in soil science; 9) Encourage soil scientists to actively engage in recruiting and career awareness; 10) Focus on student needs and areas of interest; and 11) Recruiting teams should consist of a Human Resource person, specific jobs person (soil science or conservation), and a supervisory person.

Charge 3: What impedes applicants from registering with OPM for positions such as soil scientist or soil conservationist?

Discussion focused on: 1) Human Resource people know the procedures, but the

procedures are unfamiliar to students; 2) State Personnel Office and actual job filling office disconnect is present and must be minimized through communication; 3) RECRUITING DIFFERS FROM EXAMINING; 4) OPM and NRCS inventory model is not targeted toward specific jobs at specific points in time; and 5) Forwarding job requests and applications at the same time can drastically lower applicant waiting time.

Charge 4: Explore options for electronic or Internet clearinghouse that improves information flow on positions, student applicants, scholarships, grants, and contacts with NCSS.

Discussion focused on: 1) Evaluation of transcripts for number of hours for soil science; 2) Curricula being revised constantly; 3) Online database of every single accredited college/university course catalog is currently being used by OPM to assist in evaluating coursework; 4) About 60 percent of transcripts are clear with the remaining 40 percent being unclear; 5) Listserv from GA is older; 6) OPM has a Web page, <http://www.usajobs.opm.gov/wfjic/jobs/ck0001.htm>, and also an e-mail distribution system that will greatly increase communication with selecting officials and colleges; 6) Online course descriptions are available and continue to be developed; and 7) Strategies and networks need to be developed between universities and agencies.

Action Items

1. Implement a special salary rate for GS 5-11 soil scientist positions nationwide.
 - Entry-level \$25,000 for NRCS cannot compete with private sector \$50,000.
 - High recruitment turnover and retention problems.
 - Philosophical point: Retention bonuses for younger employees will cause some upper level individuals to become upset; parity and impending retirements force us to be more proactive; and targeted levels may cause intra-agency poaching.
2. State Resource Conservationists should receive a bonus for maintaining personnel goal levels.
3. Soil Scientists must be encouraged to become more active in recruiting.
 - New hires make best recruiters.
 - Undergraduates and interns make excellent recruiters.
 - Business and public contacts development.
 - Interns can actively participate in recruiting.
4. Develop marketing materials for recruitment and retention.
 - OPM is available for formal recruitment training, marketing material development, and recruitment management.
 - Cooperative effort focused on recruiting between state agencies and national agencies.
 - Strategic Plan for NRCS includes national marketing plan for FY 2002.

5. Promote the student loan repayment program so that it is fully supported by USDA.
6. Develop contact lists for NCSS university cooperators, OPM, and agency personnel so that the process can be streamlined and communication greatly improved.
 - Potentially, 50 percent of the soil survey workforce will reach retirement age in the next 5 years.
7. Advance the possibility of Career Intern Program positions not included in the state FTE to develop “overhires” or “floating positions” that have acquired knowledge that will benefit agencies that pool knowledge for future transfer to other employees.
8. Consolidate nationwide mailing list of university contacts with various backgrounds, such as soils, forest soils, and natural resources.
 - Check ASA for lists available.
 - List of organizations and societies, chat or bulletin boards, and newsletters for posting of announcements and other opportunities.
 - Perceived knowledge of soils as related to agriculture as compared with environmental (urban planning, wildlands, range, and forestry).
 - State Conservationists’ budgets are very tight and highly competitive, so recruitment can be tied to GIS and other technology to use as bonuses for new employees.
9. Develop Career Intern Program plan so that entry-level employees are adequately prepared for future work.

Committee Attendance List

Richard W. Griffin, Prairie View A&M
Univ., TX
Jonathan W. Hooper, BIA, NM
Chris Gebauer, BIA, NM
Andy Steinert, NRCS, CO
Mike Golden, NRCS, TX
Lee A. Neve, NRCS, CO
Jon Hempel, NRCS, WI
Jim Borchert, NRCS, CO
Jason Parman, OPM, MO
Dewayne Mays, NRCS, NE
Horace Smith, NRCS, DC

Mickey Ransom, Kansas State Univ., KS
Tim Gerber, Ohio Dept. of Natural
Resources, OH
Thedis Crowe, NRCS, MT
Larry Flemig, USFS, WI
Ginger McGill, NRCS, TX
Dick Henderson, Missouri Dept. of
Natural Resources, MO
Hari Eswaran, NHQ, DC
Bob Ahrens, NRCS, NE
Maurice Mausbach, NRCS, DC
Charles Nelson, SETEC, VA

NCSS Subcommittee—Land Capability Classification: Class and Subclass

Chair—Ray Sinclair, NRCS, NSSC, Lincoln NE

A committee was established to address three issues. The issues are:

- 1) Review of the concept of the Land Capability Classification (LCC) system
- 2) Relationship of the LCC to similar land classification systems
- 3) The current and projected use of the system, including criteria for programming the LCC

Review of the concept of the Land Capability Classification (LCC) system

As conservation districts were organized throughout the country, farmers requested the assistance of the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS). The LCC afforded a fairly rapid way of doing conservation planning for the farm. The NRCS finally established its presence, and the capability concept was adopted and understood by many landholders as well as the public as a whole. For many reasons, the LCC played a significant role in the history of NRCS and soil science. NRCS's political and budgetary support allowed it to build up the Division of Conservation Surveys and to demonstrate the utility of soils information to farmers. The irony is that this success made possible the acceleration of soil survey mapping and interpretations of soils that took place after the merger of the Soil Survey Division into the Soil Conservation Service in 1952.

Relationship of the LCC to similar land classification systems

Many different kinds of land classification schemes and systems have been used in English-speaking countries, and a number of them have been adapted in other places. Land classification systems have evolved in response to the need for the classification of landscape units to help solve land use and land planning problems. Each system has been developed, usually over long periods of time (decades), with considerable amounts of effort and evaluation going into its formulation and philosophy. The desired end for which land classifications are created is an improved physical and economic environment in which people can live more productive and satisfying lives.

The LCC, Important Farmlands, and Farmland Protection Policy Act (FPPA) are land classification schemes and systems that are used by Federal, State, and local units of government. Important farmlands consist of prime farmland, farmland of statewide and local importance, and unique farmland. The Important Farmlands inventory is to be carried out in cooperation with other interested agencies at the National, State, and local levels of government. The objective of the inventory is to identify the extent and location of important rural land needed to produce food, feed, fiber, forage, and oilseed crops. Of the four types of land, only prime farmland uses national criteria. Unique farmlands have no national criteria and are different for selected areas. The criteria for farmland of statewide and local importance are developed by State agencies and jurisdictions of a county/parish or town, respectively.

Ecoregions or agro-ecoregions, as used in this paper, describe the nested geographic framework of natural landscape regions mapped at various scales for purposes of making sound ecosystem management and sustainable land use decisions. USDA has used a conceptual land resources geographic framework, often referred to as Land Resource Regions, Major Land Resource Areas, and Land Resource Units. Most of these systems have criteria that have information available by grouping soil polygons with different use and management. In contrast, LCC is specific to a soil map unit or a soil component of a soil map unit.

The current and projected use of the system, including criteria for programming the LCC

The National Resource Inventory (NRI) staff plans to continue using LCC (class and subclass). They are not opposed to having dual subclasses but would appreciate being allowed to use only the first subclass in their database, which should indicate the dominant hazard or limitation. The soil scientist assigning dual subclasses would decide which is the dominant hazard or limitation. The district, State, and National land-judging contests have LCC on their scorecards. People sponsoring these contests stated that they plan to continue having LCC (class and subclass) as part of the contests. Federal, State, and local units of government use LCC in their programs, regulations, zoning, etc. The Farmland Protection and Community Planning Staff will use LCC in the Land Evaluation (LE) part of Land Evaluation and Site Assessment (LESA) system. State and local units of government use LCC to determine farmland of statewide and local importance. The scale of the maps used by the Federal, State, and local units of government are 1:12,000, 1:15840, 1:20,000, 1:24,000, and other similar scales.

The Land Capability Classification is about 40 years old, dating back to when Agriculture Handbook 210, *Land-Capability Classification*, was published (1961), and it has withstood the test of time. It was developed during a period when there was only limited detailed (Order II soil surveys) while the need to assist land use decisions required some kind of approach. It has found applications worldwide because of its simplicity and partly because of its limited demands on data. Since its inception, many developments have taken place, including a much larger National coverage of Order II and III surveys, the National Resource Inventory, a database management system (NASIS), the ability to manipulate spatial data (GIS), and more precise concepts of soil, including resilience, sustainability, soil quality, and resource management domains. The field of soil survey interpretations was designed and implemented to utilize Order II and III soil information. However, similar concepts for smaller scale soil maps are not available. Technical Soil Services will be required to make different kinds of decisions from those dealing with Precision Agriculture (Order I surveys) to landscape units and ecosystems (Order III and IV surveys). LCC is ideally suited to the latter purposes.

Agriculture Handbook 210 needs to be revised. The revision will incorporate all new peer-reviewed science (soil properties, landscape, climate, and response of soils to management). For the U.S., the publication will provide guidelines an aggregating Order II, III, and IV surveys for use in Technical Soil Services. In areas with an Order II, III, or IV survey, a procedure will be developed to use available information and provide

estimates of the reliability of observations. A most important aspect of LCC in the revised publication will be the application of database and database management systems for making assessments.

LCC (class and subclass) will be shown in the National Cooperative Soil Survey (NCSS) database for dryland and irrigated farmland by soil map unit and components of soil map units (details are in the committee report). The LCC guides/criteria were developed by soils staffs at the National Technical Centers (NTCs) in consultation with the State Soil Scientists. These guides/criteria are used by the Major Land Resource Area Soil Survey Region Offices (MOs). Some MOs modified the guides, but not to the extent that coordination between States and regions could not accomplished. These guides/criteria, with the new science learned during the last 40 years (since the publication of Agriculture Handbook 210), will be used in developing the criteria for programming LCC into the computer.

The criteria for land capability classes will programmed in the soil interpretations module using crisp logic. A fuzzy logic number will be given for each land capability class determined by crisp logic. For example, the soil survey database will have land capability II in the first column, e in the second column, and 0.65 in the third column (the fuzzy logic number).

LAND CAPABILITY CLASSIFICATION REPORT²

Members of the Land Capability Classification (LCC) Committee

Janis L. Boettinger, Utah State University
William D. Broderson, State Soil Scientist, UT
William H. Craddock, State Soil Scientist, KY
Hari Eswaran, National Leader, World Soil
Resources, NRCS, Washington, D.C.
Micheal L. Golden, State Soil Scientist/MLRA
Office Leader, TX
Berman D. Hudson, National Leader, Soil

Survey Interpretations, NSSC, Lincoln, NE
David T. Lightle, Conservationist Agronomist,
NSSC, Lincoln, NE (Co-Chair)
Kenneth R. Olson, University of Illinois
H. Raymond Sinclair, Jr., Soil Scientist, NSSC,
Lincoln, NE (Co-Chair)
Bruce W. Thompson, State Soil Scientist/MLRA
Office Leader, MA

² The purpose of this committee report is to address the three issues. Many excellent handbooks, guides, memoranda, refereed papers, and computer programs have been written/developed on various aspects and concepts of making and using the Land Capability Classification. Some parts of this committee report have been extensively drawn from selected parts of these earlier works. Hopefully, all information from these many earlier sources, that is in this committee report, is in the literature citations. Charles E. Kellogg, Director of the Division of Soil Survey in another branch of the USDA, focused more on the general nature of the soil "in which the relevant features are considered without regard to any single purpose."

The issues are:

- 1) Review of the concept of the Land Capability Classification (LCC) system
- 2) Relationship of the LCC to similar land classification systems
- 3) The current and projected use of the system, including criteria for programming the LCC

Review the concept of the Land Capability Classification (LCC) system

Study of the development of the Land Capability Classification (LCC) sheds light on several issues. First, it illustrates the nature of the Soil Conservation Service's (SCS) relationship with farmers. Second, it shows the contending approaches to questions in the field of soil science and conservation. Third, the debates over the LCC, soil surveying, and soil mapping within the U.S. Department of Agriculture (USDA) help to make clear the connection between bureaucratic politics, science, and conservation efforts.

From the creation of the SCS under Hugh Hammond Bennett in the mid-1930s through the unification of the SCS and Division of Soil Surveys in the early 1950s, there were two main approaches to soil surveying. The SCS view was promoted by Bennett and others with strong backgrounds in soil conservation work. They tended to stress the need to focus on agriculture. As a result, during the 1930s and 1940s the SCS created an LCC system which became an important tool in recommending to farmers practices needed to conserve their land. As the system developed, eight classes of land, with subclasses and capability units, were eventually created. This work was generally done at the farm level and was vital in gaining local support for the SCS in its early years. The LCC underwent regular modifications in the 1940s and 1950s. One constant difficulty was the lack of uniformity, as classification was often relative within a State or region.

In 1952, the surveys were unified in SCS under Kellogg. He refined the LCC but retained it as one of many interpretations of soil surveys. The Universal Soil Loss Equation (USLE) supplanted the LCC's on-farm planning function in the 1980s. However, the LCC remains today an important tool for natural resource inventories, training, education, and international activities. Ironically, SCS's early success helped create the legislative support, in-house expertise, and national organization which made it possible for Kellogg to accelerate soil surveys and develop interpretations of soil survey for diverse uses.

Albert A. Klingebiel worked in the 1950s on a revision of LCC which would give soil scientists "specific basic criteria and assumptions to use to place soils into units, subclasses, and classes." It was an effort to make the system national and to tighten the criteria in an attempt to ensure that any particular soil would be classed similarly wherever it occurred. It would leave less room for individual interpretations in classifying soil. The studies and work that went into Agricultural Handbook 210 reconciled some of these discrepancies in classification. Also, the published soil surveys, after the merger of the two surveys, began placing the soils into the LCC.

In summary, there might be consensus among soil scientists that Charles E. Kellogg's

approach to soil interpretations was superior, but this question should not be viewed strictly in terms of “better science.” Bennett’s support of land capability classification must be understood historically in the context of the whole conservation movement. The early Soil Conservation Service faced strong opposition from people who would have preferred to see any soil and water conservation work carried out through the state extension services and the land grant universities. As conservation districts were organized throughout the country, farmers requested assistance from SCS. The LCC afforded a fairly rapid way of doing conservation planning for the farm. SCS finally became established, and the capability concept was adopted and understood by many landholders as well as the public as a whole. For these reasons, the LCC played a significant role in the history of SCS and soil science. From this point of view, LCC was a resounding success due in no small part to Bennett’s success at promoting an action program of soil conservation. SCS’s political and budgetary support allowed it to build up the Division of Conservation Surveys and to demonstrate the utility of soils information to farmers. The irony is that this success made possible the acceleration of soil survey mapping and interpretations of soils that took place after the merger of Charles E. Kellogg’s Soil Survey Division into the Soil Conservation Service in 1952.

Relationship of the LCC to similar land classification systems

Many different kinds of land classification schemes and systems have been used in English-speaking countries, and a number of them have been adapted in other places. Land classification systems have evolved in response to the need for the classification of landscape units to help solve land use and land planning problems. Each system has been developed, usually over long periods of time (decades), with considerable amounts of effort and evaluation going into its formulation and philosophy. Diverse environments have a variety of land problems and different resources to meet the needs. Land classification is a means toward an end and not an end in itself. The desired end for which land classifications are created is an improved physical and economic environment in which people can live more productive and satisfying lives.

LCC, Important Farmlands (IF), and Farmland Protection Policy Act (FPPA) are land classification schemes and systems that are used by Federal, State, and local units of government.

IF consists of prime farmland, farmland of statewide and local importance, and unique farmland. The IF inventory is to be carried out in cooperation with other interested agencies at the National, State, and local levels of government. The objective of the inventory is to identify the extent and location of important rural land needed to produce food, feed, fiber, forage, and oilseed crops. Of the four types of land, only prime farmland uses national criteria. The land capability class in areas of prime farmland generally is I or II but in some areas is III.

Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply to economically produce sustainable high quality and/or high yields of a specific crop when treated and managed according to

acceptable farming methods. Examples of such crops are citrus, tree nuts, olives, cranberries, fruit, and vegetables. Unique farmland has no national criteria and can differ from area to area.

Farmland of statewide importance is land, in addition to prime and unique farmlands, that is used for the production of food, feed, fiber, forage, and oilseed crops. The criteria for defining and delineating this land are to be determined by the appropriate State agency or agencies. Generally, farmland of statewide importance includes areas that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some areas may produce as high a yield as prime farmland if conditions are favorable. In some States farmland of statewide importance may include tracts of land that have been designated for agriculture by State law. The land capability class in areas of farmland of statewide importance generally is III or IV but in some areas is VI.

In some areas that are not identified as having National or statewide importance, land is considered to be farmland of local importance for the production of food, feed, fiber, forage, and oilseed crops. Where appropriate, this land is identified by the appropriate local agency or agencies. In places farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance. Farmland of local importance could have any land capability class. At the present time this kind of farmland is not identified by most jurisdictions.

FPPA sets out the criteria developed by the Secretary of Agriculture, in cooperation with other Federal agencies, pursuant to section 1541(a) of the Farmland Protection Policy Act (FPPA) or Act 7 U.S.C. 4202(a). As required by section 1541(b) of Act 7 U.S.C. 4202(b), Federal agencies are (a) to use the criteria to identify and take into account the adverse effects of their programs on the preservation of important farmland, (b) to consider alternative actions, as appropriate, that could lessen adverse effects, and (c) to ensure that their programs, to the extent practicable, are compatible with State and local government and private programs and policies to protect important farmland. Guidelines to assist agencies in using the criteria are included in this part. The Department of Agriculture (USDA) may make available to States, units of local government, individuals, organizations, and other units of the Federal Government information useful in restoring, maintaining, and improving the quantity and quality of important farmland. FPPA is usually specific to a jurisdiction. It usually rates tracts of land containing important farmlands within a jurisdiction.

Ecoregions or agro-ecoregions, as used in this paper, describe the nested geographic framework of natural landscape regions mapped at various scales for purposes of making sound ecosystem management and sustainable land use decisions. USDA has used a conceptual land resources geographic framework, often referred to as Land Resource Regions, Major Land Resource Areas, and Land Resource Units, for more than 8 decades. Following is a description of this land resources framework.

The present-day MLRA framework relies on the delineation of regions that share

common patterns of land use, climate, soils, water resources, terrain, topography, geology, and potential natural vegetation at a particular scale. The MLRA framework is the second level in a four-tiered hierarchical framework. MLRAs nest within Land Resource Regions (LRRs), the first and most general tier. Land Resource Units (LRUs), also called Common Resource Areas (CRAs), are the third tier and nest together to form MLRAs. The LRUs/CRAs represent landscape segments, several thousand acres in extent and are created from state general soil map units. The state general soil map units are the fourth tier in the hierarchy. This hierarchy existed for LRRs and MLRAs in hand-drawn maps and only conceptually for LRUs/CRAs and state general soil map units until the publication of the digital State Soil Geographic Data Base, referred to as STATSGO.

It is the LRU/CRA level that appears to be appropriate for use with the Land Capability Classification (LCC) system (class and subclass), except that the LCC system does not include consideration of land use and potential natural vegetation. In assessing, planning, and zoning, it is important to know the location of each kind of soil, its extent, and its general suitability for various uses. Soil maps interpreted into eight capability classes provide this general information. Capability classes are set up so the soils having the greatest alternatives uses are in class I and those having the least are in class VIII. When uses are considered collectively, the risks or limitations become progressively greater from class I to class VIII land. LCC for class and subclass are at a scale of 1:12,000 to 1:250,000. Soil landscape, climate, and soil properties that define a given LCC class or subclass appear to group those portions of the landscape together that somewhat approximate LRU/CRA regions. The LRU/CRA level concept correlates well with the resource management domains (RMD)s described by Eswaran et al. (2000), agro-ecological resource areas (ARAs) described by Dumanski et al. (1993), ecodistricts described by the Canada Committee on Ecological Land Classification (1996), subsections described by McNab et al. (1994) and level 4 ecoregions described by Omernik (1995). The cartographic scale for mapping these concepts ranges from 1:12,000 to 1:3,000,000 but is generally 1:1,000,000 to 1:250,000.

Although, the purpose of the LRU/CRA is very similar to the intended purpose of the LCC, their pathways evolved separately—one geographic, the other categorical. New technologies bring these historic concepts together for re-evaluation. Powerful computer systems, Internet access, geographic information systems, and available digital geographic data allow testing of these concepts against known landscape behavior and function.

Biology, socio-economic, and biophysical characteristics are used in the hierarchy for attributes of land management units for “Resource Management Domains: a biophysical unit for assessing and monitoring land quality.” Most of the socio-economic and biophysical characteristics are not included in LCC, but nearly all of these characteristics are considered in FPPA.

Is it necessary to recognize soil map units at a higher order of abstraction? Why not deal only with soil map units or components of soil map units? Higher abstraction at the LCC (class and subclass) level is an expedient means of communication that is brief but covers

the subject. It would take a long time to describe all the various kinds of soil. Such a description would be cumbersome, and it would be impossible to express in a few words the really important major differences between soils. Generalizations using LCC, therefore, are an expedient method of improving the transfer of knowledge.

The current and projected use of the system, including criteria for programming the LCC

The National Resource Inventory (NRI) staff plans to continue using LCC (class and subclass). They are not opposed to having dual subclasses but would appreciate being allowed to use only the first subclass in their database, which should indicate the dominant hazard or limitation. The soil scientist assigning dual subclasses would decide which is the dominant hazard or limitation. The district, State, and National land-judging contests have LCC on their scorecards. People sponsoring these contests stated that they plan to continue having LCC (class and subclass) as part of the contests. Federal, State, and local units of government use LCC in their programs, regulations, zoning, etc. The Farmland Protection and Community Planning Staff will use LCC in the Land Evaluation (LE) part of the Land Evaluation and Site Assessment (LESA) system. State and local units of government use LCC to determine farmland of statewide and local importance. The scale of the maps used by the Federal, State, and local units of government is 1:12,000 to 1:24,000.

At the present, only the subclass that connotes the major management concern is assigned to a soil. The committee members agreed that dual subclasses (ew, sw, es) could be assigned to soil map units and component(s) of map units (as is indicated in Agriculture Handbook 210). For example, an ew subclass could be assigned to a soil that has both erosion and wetness concerns, and es could be assigned to a shallow soil that has both erosion and available water capacity concerns.

Limitations imposed by erosion, excess water, shallow soils, stones, a low moisture-holding capacity, salinity, or sodium can be modified or partially overcome and take precedence over climate in determining subclasses. The dominant kind of limitation or hazard to the use of the land determines the assignment of capability units to the (e), (w), and (s) subclasses. Capability units that have no limitation other than climate are assigned to the (c) subclass.

Capability classes II through VIII can have one or two subclasses assigned to reflect soil limitations. For example, a particular soil in capability class II may have a limitation due to erosion (e) and an additional limitation due to wetness (w). This soil would be assigned to two subclasses, IIw and IIe. Which subclass to use, or whether to use both of them, will depend upon the purpose of the interpretation or analysis being done.

Where soils have two kinds of hazards or limitations, both can be indicated, if needed, for local use; the one with the greatest hazard or limitation to sustainability of the soil resource is shown first. Where two kinds of limitations that can be modified or corrected are essentially equal, the subclasses have the following priority: e, w, and s. Soils that

have no limitation other than climate are assigned to the (c) subclass. Where two kinds of hazards or limitations are shown for a soil, the greatest hazard or limitation to sustainability of the soil resource is usually used for summarizing data by subclasses.

Class IV soils are suited to cultivated field crops, and classes V and VI soils are suited to grazing, woodland, and wildlife habitat. If special management is applied, however, some soils in classes V and VI can be cultivated safely. Most class IV land is cultivated in a rotation with many years of meadow (hayland and occasionally pasture), contoured, terraced, or managed by a combination of these systems. Typically, class VI land is pasture, in some areas is hayland, and is cultivated every decade or so to control weeds and to reseed to more desirable grasses and legumes for pasture. For many reasons, terraces on class VI land were never really accepted by farmers in most of the United States. Exceptions are areas of ustic-udic or udic-ustic moisture regimes where terraces were accepted by farmers as a conservation practice to allow time for the precipitation to infiltrate into the soil instead of running off. The intent of terracing in these areas was to increase the amount of soil moisture for plant growth and increase yields rather than specifically control erosion.

Assumption 9 in Agriculture Handbook 210 reads as follows:

The capability classification of the soils in an area may be changed when major reclamation projects are installed that permanently change the limitations in use or reduce the hazards or risks of soil or crop damage for long periods of time. Examples include establishing major drainage facilities, building levees or flood-retarding structures, providing water for irrigation, removing stones, or large-scale grading of gullied land. (Minor dams, terraces, or field conservation measures subject to change in their effectiveness in a short time are not included).

Conservation tillage, especially no-till, is new technology that allows cultivation within tolerable soil loss limits on some class VI lands. An example is a soil with a T factor of 5, an R factor of <220 , and a K factor of ≤ 0.37 , or a combination of these three factors that is within the allowable soil loss limits. No-till farming is an example of the minor “field conservation measures” rather than the “major reclamation projects” mentioned in the description of assumption 9 in Agriculture Handbook 210. Thus, Alpha silt loam, 12 to 18 percent slopes (which would be in class I except that slope makes it class VI) would remain in class VI even if it is farmed by a no-till system. Our experience is that a person farming the land may switch back to conventional tillage or mulch tillage in any given year and negate the no-till benefits.

By policy, crop yields (for corn, wheat, cotton, etc.) on historical class VI lands are not to be shown in published soil surveys or Field Office Technical Guides. Yields for class VI lands are in the soil survey database for use in Federal programs. They were first put into the soil survey database in the late 1980s.

The description of class I soils in Agriculture Handbook 210 indicates:

In irrigated areas, soils may be placed in class I if the limitation of the arid climate has been removed by relatively permanent irrigation works. Such irrigated soils (or soils potentially useful under irrigation) are nearly level, have deep rooting zones, have favorable permeability and water-holding capacity, and are easily maintained in good tilth. Some of the soils may require initial conditioning including leveling to the desired grade, leaching of a slight accumulation of soluble salts, or lowering of the seasonal water table. Where limitations due to salts, water table, overflow, or erosion are likely to recur, the soils are regarded as subject to permanent natural limitations and are not in class I.

This paragraph implies that if the soils had in a udic moisture regime, then they would be class I. Because they are arid, they need to be irrigated to be class I. Also, the paragraph implies that with a sufficient quantity of good-quality irrigation water, these soils will never have any undesirable limitation recur that would make them some class other than I. In most areas presently irrigated, soils growing the present crop(s) will salt out in the next decade or two or the quantity/quality of water will not be available to continue irrigating the areas. Probably, there are a few areas in the West where these soils are class I if irrigated. No one on the committee seemed to disagree with the paragraph. It is important to emphasize that irrigation alone will not always change the land class to I. For example, irrigation alone will not change subclass I_{ve} to class I in the West. Is it usually correct that soils in the West that need irrigation and have assigned subclasses, particularly e and s, would not be class I with only an adequate quantity of good-quality irrigation water? If so, then the message needs to be gotten out to emphasize this point.

There are reasonable or optimum scales for making soil survey interpretations (SSI) and LCC. The optimum scale for making SSI and LCC seems to be dictated by the scale of the soil survey. A few decades ago that scale was usually 1:15840 and 1:20000. Today, most soil surveys are made at 1:24000 and 1:12000. These scales seem to be determined more by economics and/or politics than by science. In the United States our agency has used soil survey for making SSI and LCC. NRI uses point sampling and expands the points (each point represents so many acres in a land area—MLRA, State, U.S., etc.). If we are referring to thematic maps for SSI and LCC, then the user or maker decides the scale (1:500 to 1:15,000,000). For conservation farm planning, the LCC maps given to the cooperator were at a scale of 1:7920. One of the rationales for this scale was so the LCC map would be the same scale as the conservation-planning map (showing fields, conservation practices, etc.). Experience shows that users of soil surveys always seem to make their thematic maps at a larger scale than that of soil survey maps.

In the early years of the SCS (now NRCS), LCC afforded a fairly rapid way of doing conservation planning for the farm. The Universal Soil Loss Equation (USLE) supplanted the LCC as an on-farm planning function in the 1980s. However, the LCC remains today an important tool for natural resource inventories, the Land Evaluation (LE) part of Land Evaluation and Site Assessment (LESA) system, determinations of farmland of statewide and local importance, training, education, and international activities. Today, the LCC is

used more as a screening tool than as a way of doing conservation planning for the farm. Where the LCC is used as a screening tool, scales of 1:12,000 to 1:250,000 probably are satisfactory. Resource management domains (1:25,000 to 1:250,000), Land Resource Units/general soil maps/land resource maps (1:190,080 to 1:253,440), and STATSGO (1:250,000) are some of the different names for similar information.

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References

- 1) Bailey, R. 1996. Ecosystem Geography. Springer-Verlag, New York.
- 2) Bauer, K. W. 1966. Application of Soils Studies in Comprehensive Regional Planning. p. 42 –59. In L. J. Bartelli, A. A. Klingebiel, J. V. Baird, and M. R. Heddlson (ed.). Soil Surveys and Land Use Planning. ASA, CCSA, and SSSA, Madison, WI.
- 3) Bouma, J., A. Kuyvenhoven, B. A. M. Bouman, J. C. Luyten, and H. G. Zandstra. 1995. Eco-regional approaches for sustainable land use and food production. Proceedings of a symposium on eco-regional approaches in agricultural research, 12-16, ISNAR, The Hague. Kluwer Academic Publishers in cooperation with International Potato Center (CIP). 505 pages.
- 4) Bureau of Plant Industry, Soils, and Agricultural Engineering. 1950. Sound Land Classification Rests on Soil Surveys. p. 1-8. Agricultural Research Administration. U.S. Department of Agriculture, Beltsville, MD.
- 5) Cangir, C., S. Kapur, D. Boyraz, E. Akca, and H. Eswaran. 2000. An Assessment of Land Resource Consumption in Relation to Land Degradation in Turkey. Journal of soil and Water Conservation 3:253-259.
- 6) Cline, M.G. 1977. Historical Highlights in Soil Genesis, Morphology, and Classification. Soil Science Society of American. Journal 41: 250-254.
- 7) Code of Federal Regulations. 7CFR657.1-0.5. 2001. Important Farmland Inventory. Office of the Federal Register, National Archives and Records Administration.
- 8) Code of Federal Regulations. 7CFR658.1-0.7. 2001. Farmland Protection Policy Act. Office of the Federal Register, National Archives and Records Administration.
- 9) Daily, L. D. 1948. The Colorado Reappraisal. P. 160-165. In Ronald B. Welch (ed.) Proceeding of the Forty-First Annual Conference on Taxation, held under the auspices of the National Tax Association. Denver, Colorado. October 4-7, 1948.
- 10) Dumanski, J., WW. Pettapiece, D. F. Action, and P.P. Claude. 1993. Application of agro-ecological concepts and hierarchy theory in the design of databases for spatial and temporal characterization of land and soil. *Geoderma*, 60 (1993) 343-358.
- 11) Ecological Stratification Working Group. 1996. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. Report and national map at 1:7,500,000.
- 12) Eswaran, H ., F. H. Beinroth, and S. M. Virmani. 2000. Resource management domains: a biophysical unit for assessing and monitoring land quality. Elsevier. Agriculture, Ecosystems and Environment 81:155-162.
- 13) FAO. 1996. Agro-ecological zoning. Guidelines. Ed:1 Vol:73.
<http://www.fao.org/docrep/W2962E/W2962E00.htm>
- 14) FAO. 1999. AEZWIN An interactive multiple-criteria analysis tool for land resources appraisal (with CD-Rom included). World Soil Resources Report- Series 87. <http://www.fao.org/icatalog/inter-e.htm>
- 15) Fischer, G., H.T. van Velthuisen, F.O. Nachtergaele. 2000. Global Agro-Ecological Zones Assessment: Methodology and Results. IIASA - International Institute for Applied System Analysis and FAO - Food and Agriculture Organization of the United Nations.
http://www.iiasa.ac.at/docs/Admin/PUB/Catalog/PUB_ONLINE.html

- 16) Fischer, G., J. van Velthuis, and F. Oo Nachtergaele. 2000. Global Agro-Ecological Zones Assessment: Methodology and Results. International Institute for Applied Systems Analysis (IIASA)

2001 National Cooperative Soil Survey Conference

- 40) Soil Survey Staff. August 11, 1959. Land Capability Subclass. Soils Memorandum SCS-30. Soil Conservation Service, Washington, D.C.
- 41) Thompson, Pamela J., Keith Young, William D. Goran, Al Moy, Kimberly A. Majerus, James W. Danelly II, and Cynthia Balek. March 1992 (revised). Users' Manual for CALES. Technical Report N-87-18, 1987. U.S. Army Corps of Engineering, Construction Engineering Research Laboratory (USACERL) and USDA-SCS. Champaign, Illinois.
- 42) U.S. Department of Agriculture. 1965. Soil and Water Conservation Needs – A National Inventory. p. 1-94. Miscellaneous Publication No. 971. Washington, D.C.
- 43) USDA-Soil Conservation Service. 1981. Land Resource Regions and Major Land Resource Areas of the United States. USDA-NRCS Agricultural Handbook 296. Revised 1984. Govt. Printing Office, Washington, D.C.
- 44) U.S. Forest Service. 1994. Ecological Subregion of the United States: Section Descriptions. WO-WSA-5. Compiled by W. H. McNab and P. E. Avers. Prepared in cooperation with Regional Compilers and the ECOMAP Team of the Forest Service. July 1994.

NCSS Cooperators' Reports

USFS Highlights—Initiatives for Future Interagency Cooperative Efforts

Jim Keys, Ecosystem Management Coordination, Resource Information Group, National Coordinator for Integrated Inventories

Randy Davis, Watershed, Fisheries, Air, and Rare Plants, National Soils Program Manager

Introduction

The Forest Service has initiated key activities that will provide for continued opportunities in interagency cooperation.

Program Components

1. Inventory
2. Integrated Inventory/Terrestrial Ecological Unit Inventory—Land Unit, Landscape/Forest, Subregional, National Levels
3. Soil Investigations/Inventory—Project Level
4. Monitoring
5. Land and Resource Management Plan Monitoring/Implementation and Effectiveness of Soil Quality Standards and Guides
6. Soil Resource Condition Monitoring
7. Soil Management Support Services
8. Project Development and Implementation
9. Forest Watershed/Landscape Assessments and Planning
10. Broad-Scale Assessments and Planning

Integrated Inventories

Resource Inventories

1. 5 Types; 2-4 Scales/Inventory
2. Ecological Unit Inventories
3. Terrestrial Ecological Unit Inventories
4. Aquatic Ecological Unit Inventories
5. Air Quality Related Values
6. Existing Vegetation
7. Fauna
8. Terrestrial Fauna
9. Aquatic Biota
10. Human Dimensions
11. Social and Economic Inventories
12. Heritage Resource Inventories

Resource Mapping

18 GIS Core Layers/GIS Themes/1:24,000

Examples:

- ✓ Terrestrial Ecological Unit Inventory Theme
- ✓ Soils
- ✓ Bedrock Geology
- ✓ Potential Natural Vegetation
- ✓ Geomorphology
- ✓ Heritage Resource Theme
- ✓ Heritage Resource Sites
- ✓ Heritage Resource Surveys
- ✓ National GIS Core Data Standards

Discussion Topics

Forest Service Inventory and Monitoring Framework

- ✓ Corporate Resource Information Management
- ✓ Forest Service Inventory and Monitoring Framework
 - The Forest Service is aggressively implementing strategies to improve the credibility and efficiency of inventory and monitoring programs throughout the agency.

Strategies utilize sharable data that is collaboratively developed, integrated, and interagency in design.

Forest Service Inventory and Monitoring Framework

Inventory and Monitoring Issue Team (IMIT)

- ✓ Members of field and WO Staffs and partner organizations (NRCS, BLM, EPA, USGS, TNC, and others)
- ✓ Membership includes a core team, an extended team, and working groups
- ✓ Working groups are associated with focus areas

Forest Service Inventory and Monitoring Framework

Focal Areas:

1. Work within overarching Purpose and Business Requirements.
2. Embrace a multi-scale, ecological, social, and economic system framework.
3. Collaborate across ownerships and governments for sharing and acquiring data.
4. Communicate and provide accountability.
5. Organize to efficiently coordinate, integrate, and manage inventories and monitoring with adequate skills.
6. Establish protocols for consistent, efficient, and effective inventories and monitoring.

I&M Focal Area: Communicate and provide accountability.

Strategic Planning for Inventories/Objectives:

1. Ecosystem Management Coordination
2. Develop realistic forecast of national needs.

3. Develop a basis for program accountability and funding of inventories.
4. Regions
5. Coordinating accomplishment of NFIM-supported inventories and resource mapping to support regional priorities
6. Scheduling inventories to support assessments and forest plan revisions and determine program needs
7. Tracking and updating the status of NFIM-supported inventories

I&M Focal Area: Communicate and provide accountability.

Strategic Planning for Inventories:

1. Five-year plans and Schedule
2. Budget and Personnel Needs
3. Includes Resource Inventories and Core GIS Layers

I&M Focal Area: Set protocols for consistent, efficient, and effective inventories and monitoring.

Terrestrial Ecological Unit Inventory Standards and Protocols

1. Using NCSS standards for the soils component
2. Developing standards for mapping conventions, integrated plots, and developing and validating ecological types
3. Developing a process to test data standards, business rules, and protocols
4. Defining a TEUI correlation process
5. Transitioning from current business rules and protocols to agency direction

Forest Service Inventory and Monitoring Framework

Key Concepts—Terrestrial Ecological Unit Inventory

1. Incorporation of National Hierarchical Framework for Ecological Units
2. Land type and land type phase level mapping (1:24,000)
3. Emphasis on ecological types developed from integrated plots
4. Use of interdisciplinary field crews
5. More emphasis on climate, vegetation, geology, and geomorphic elements
6. Use of FGDC soil subcommittee standards (map unit and component)

Forest Service Inventory and Monitoring Framework

Timeline—Terrestrial Ecological Unit Inventory Standards and Protocols Activities

1. TEUI Technical Guide Peer Review: Oct. 1, 2001–Dec. 3, 2001
2. Conduct workshops at pilot test areas/Feb.–April 2002.
3. Pilot tests in progress/May–Oct. 2002
4. I&M Framework—opportunities for cooperation
5. Coordinate on development of planning for terrestrial ecological unit inventory.
6. Joint field review of Forest Service TEUI standards and protocols
7. Coordinate correlation activities between soil survey and terrestrial ecological unit inventory.

8. Update the 2/28/1961 MOU to reflect the evolution of environmental concepts, scientific understanding, management experience, public expectations, and advances in technology.

Corporate Resource Information Management

1997—Initiative begun to develop an integrated, corporate Natural Resource Information System (NRIS)

NRIS consists of six database modules that represent natural resource business areas (Air, Fauna, Field Sampled Vegetation, Terra, Water, and Human Dimensions). Development and implementation are chartered by the HDQ Directors and Deputy Regional Foresters and administered by Forest Service HDQ Ecosystem Management Coordination Staff. Branch Chiefs provide day-to-day administration of module development. A full-time staff is dedicated to development, installation, and training for each module.

Corporate Resource Information Management

Timeline

1. NRIS modules began distribution in 1998.
2. Installation in Ranger Districts, Forests, and National Grasslands
3. Deployment will be nation-wide by the end of 2002.

Corporate Resource Information Management

NRIS—Terra

Terra is “corporate,” which means it standardizes the way natural resource data are entered, stored, retrieved, analyzed, and reported throughout the agency. Terra focuses on five resource areas: (1) soils, (2) geology, (3) geomorphology, (4) vegetation, and (5) climate. Terra is being developed by field people and for field people. It reduces costs by replacing hundreds of noncorporate “satellite” databases.

Corporate Resource Information Management

Opportunities for Coordination

1. Re-initiate FGDC process to complete work on interagency standards for point or site data, landforms and landscapes, and vegetation.
2. Provide for data exchange of soil survey information among cooperators sufficient to meet National Cooperative Soil Survey Standards. Consider the technology environments and mission critical objectives of each agency or cooperator.

What This Means

1. The Forest Service affirms its commitment to the National Cooperative Soil Survey (NCSS) and NRCS as keepers of the soil correlation process.
2. We will continue to provide quality soils data for use by NCSS cooperators and the public.

Interagency cooperation and progress on key Forest Service initiatives are mission critical.

Summary

- ✓ The Forest Service is aggressively implementing strategies to improve the credibility and efficiency of inventory and monitoring programs throughout the agency.
- ✓ Inventory and monitoring framework
- ✓ Strategic inventory planning
- ✓ Development of standards and protocols for all inventories
- ✓ Strategies utilize sharable data which is collaboratively developed, integrated, and interagency in design.
- ✓ Corporate, consistent information through the Natural Resource Information System
- ✓ Standards for 19 core GIS layers
- ✓ Continued interagency cooperation through FGDC

USDA, Forest Service: Standards Update

Eric Winthers, USFS, Washington Office

Ecosystem Management Coordination—Overview

Current standards development for Terrestrial Ecological Unit Inventory (TEUI).
Recommendations to NCSS Steering Committee for future work in standards development.

TEUI Objectives

1. To provide a systematic method for classifying and mapping areas of the earth based on associations of ecological factors at different geographical scales.
2. To support planning and assessments at the National, Regional, and Forest level.
3. To achieve consistency in ecosystem management across agency administrative units.

Policy

1. Develop ecological types and map ecological units for characterizing ecosystem composition, structure, and function.
2. Provide coordination and integration of resource inventories for making predictions and interpretations about ecological sustainability.
3. Coordinate the characterizations of ecological types with other agencies and partners.

TEUI Standards Development

1. Refinement of TEUI mapping conventions.
2. Methodologies for field sampling of integrated plots.
3. Developing and validating Ecological Type classifications.
4. Use of geologic terms.
5. Describing geomorphology.
6. Create a field guide for conducting TEUI
7. Define a standard to compare existing inventories against.

TEUI Standards Team

Ten people across the agency with expertise in:

- * Soils
- * Ecology
- * Geology
- * Geomorphology

TEUI Key Concepts

1. Incorporation of National Hierarchical Framework of Ecological Units, Cleland et al., 1993, 1997.
2. Land type and land type phase level mapping.
3. Emphasis on ecological types developed from integrated plots.
4. Use of interdisciplinary field crews.
5. More emphasis on climate, vegetation, geology, and geomorphic elements.

Recommendations for Future Standards Work

1. Vegetation
2. Sampling and classification methods
3. Geomorphic terminology
4. Refining landform terms for use in mapping
5. Geologic
6. Lithology terms used to describe map unit components
7. Parent material
8. Bedrock structure

Soils Inventory and Monitoring Program in the National Park Service (NPS)

Pete Biggam, Soil Scientist, Natural Resource Program Center, Lakewood, CO

NPS Soil Resources Management

“Although No NPS Units have Park Enabling Statutes with *specific* references to soil resources, *virtually all* NPS Units confront soil management issues in one way or another.”

“Only by having reliable scientific information can park managers take corrective actions before those impacts severely degrade ecosystem integrity or become irreversible.”

NPS Soil Resources Management & NPS Soil Survey

The NPS Inventory and Monitoring Program is obtaining soil surveys on Park Units through agreements with other Federal agencies, such as the Natural Resources Conservation Service (NRCS), and with private contractors.

NPS Soil Survey

“All soil surveys will follow National Cooperative Soil Survey (NCSS) Standards.”

“Mapping will be at Order 3 Level, except where more detailed surveys are required for park management.”

NPS Soil Survey Products

1. Local Park Soils Scoping Session
2. Soils map in digital and “hard copy” formats, including polygon, linear, and point inferences
3. Soil map attributes for all soil inferences
4. FGDC compliant metadata
5. Soil survey manuscript with pedon and landscape images
6. Soil interpretation and education products
7. Soils “Fact Sheet” for concise information at an overview level
8. “Soil-Forming Factors” maps/graphics to provide users concepts on why soils differ within a park
9. Soil monoliths
10. Soils information in a NPS GIS Theme Manager Format
11. We also want to look at different ways of naming soil map units to allow for more assimilation into NPS activities.
12. Less taxonomically based, more landscape based

Denali NP Map Unit Names and Rules

Dual naming convention—life zone, soil, and landform
soil taxonomic name

Unique to a physiographic division

Unique map unit prefix for digital aggregation purposes

Component example:

Map unit 2FP3—two named components

Landscape component names

- 1) Boreal-riparian scrub gravelly low flood plains
- 2) Boreal-riparian forested loamy high flood plains

Taxonomic component names

- 1) Oxyaquic Cryorthents, sandy-skeletal
- 2) Typic Cryofluvents, coarse-loamy

Map unit 2FP3—soil/landscape components:

Component—Boreal riparian scrub gravelly low flood plains

Subsection: Kuskokwim Plain—Flood Plains and Terraces

Life zone: Boreal

Landform: Low Flood Plain

Soil: Sandy-skeletal, mixed, nonacid Oxyaquic Cryorthents
PNC: Mixed alder-willow scrub

Component—Boreal riparian forested loamy high flood plains
Section: Kuskokwim Plain-Flood Plains and Terraces
Life zone: Boreal
Landform: High Flood Plain
Soil: Coarse-loamy, mixed, nonacid Typic Cryofluvents
PNC: Open white spruce-willow forest

The Future of NPS Soil Surveys

National Soil Information System (NASIS)

Thirty-seven parks have soil mapping complete at this time.
Mapping is in progress in an additional 117 units.
Processing SSURGO datasets on 45 units through Colorado State University—PASIS

NPS Soil Survey Activities for 2001

Soils mapping initiated on four units
Soil scoping sessions initiated on five units
Development of NPS soil data user guides and GIS tutorial
On-site training and assistance

Soil Interpretation and Education

1. The NPS has an excellent opportunity to raise the awareness of the public in regards to the value of our soil resources nationwide.
2. Over 285 million people visited our parks in 2000.
3. Over 137 million people have visited our Web site to date in 2001.
4. Over 3.2 million people visited Rocky Mountain NP in 2000.

Soils and Cultural Resources—Soils help tell the story.

Soils and Threatened and Endangered Species (burrowing owl, desert tortoise, & plants endemic to soils like the Brady pincushion cactus)

Fragile and Unique Soils—cryptobiotic soils, gypsiferous soils

Exotic plant invasion potential is a factor of soil and other environmental- and human-induced conditions

Future Directions

Continue the use of new techniques in soil survey mapping concepts.
Adoption of soil quality concepts.
Utilization of Ecological Sites and Tate and Transition Models.

Protecting Soil Diversity

“Soils are natural bodies that take thousands to millions of years to develop, and, unlike living species, they do not reproduce nor can they be recreated.”

Bureau of Land Management (BLM) Highlights

Bill Ypsilantis, USDI/BLM, Lakewood Colorado

The Bureau of Land Management faces many new challenges in managing the 264 million surface acres under our jurisdiction. Our high-priority issues are ever evolving and changing. The new administration has identified several high-priority issues for the Bureau.

Energy and mineral production are seen as paramount to helping solve the current energy crisis and revitalizing our economy. A \$15 million spending increase was proposed for the fiscal year 2002 budget. Soil information is vital to reclamation efforts.

Land use planning is needed to update some of our outdated plans. A \$7.1 million funding increase in fiscal year 2002 is being used to update 47 land use plans Bureau wide. Soil information is needed to support these planning efforts.

An effort is underway to identify high-priority sub-basins and watersheds to focus our management emphasis upon. Limited discretionary funding and personnel would be concentrated on implementing management actions in these areas.

A total of \$ 658.4 million has been allocated for wildland fire management, which is double the historical levels. Soil information is needed to predict potential fuel loads, fire impacts, and other analysis.

Supporting communities that depend on the resources and opportunities of the public lands is another high-profile issue. The economic well being of these communities must be taken into consideration when land management decisions are made.

Managing and protecting special areas containing unique natural, historical, or cultural resource values will continue to be emphasized.

Continuing to address the backlog of deferred maintenance of campgrounds, roads, and buildings is being aggressively pursued. Soil information is needed to rate road stability, the need to reroute or close roads, and other related issues.

Maintaining the health of the land for a wide range of public values, such as watershed protection, exotic weed control, and abandoned mine land restoration, continues to be a high-priority issue.. The Bureau's rangeland health assessment process relies upon soil and ecological site information to compare current conditions to reference conditions. This has been one of the best tools we've had to highlight the need for soil survey information.

The soil program emphasis within the Bureau is shifting from inventory to providing quality soil information from existing soil surveys to our customers, the managers and other resource specialists who use this soil information in the land management decision-making process.

Soil information must be provided in a digital/automated format. This is the wave of the future for use of resource information. The Soil Data Viewer and other similar technology are very promising tools that the Bureau is very interested in utilizing.

Nonstandard interpretations need to be developed for forest and rangeland ecosystems. The increasing pressures on these ecosystems from a wide range of uses and heightened interest in the health of the land dictate that soil interpretations address these issues. There has been some progress recently in creating new forest interpretations, notably in Oregon. However, such issues as slope stability and cumulative impact analysis need to be addressed. Standard rangeland interpretations do not address many of the Bureau's management actions or concerns. We need to work together to remedy this situation.

Soil information must be reliable, readily accessible, and relevant to the Bureau's needs. The reliability of soil information is becoming more important as more of our management actions are challenged in court. Managers demand resource information that is easy to obtain, easily understood, and useful in making a management decision.

The soil expertise in the Bureau has steadily declined and is scarce or nonexistent in some field locations. This situation needs to be remedied if the Bureau is to make sound decisions based upon our knowledge of ecosystem functions and processes.

The Bureau must maintain a skilled soil scientist workforce by promoting training and technology transfer. The science is advancing at a rapid pace, and our workforce needs to be kept abreast of new information and new ways of utilizing this information.

New mapping technology has the potential to revolutionize the way that soil and other resource inventories are conducted. The Bureau is very interested in promoting the development of this technology and application of it on Bureau lands.

Currently, soil surveys have been completed on over 81 percent of public lands in the lower 48 states with over 56 percent of the mapped acreage digitized. Alaska has less than 1 percent of its public lands mapped. Order 3 or higher soil surveys have been completed on over 143 million acres of public land. However, some areas with critical soil information needs remain unmapped, millions of acres of soil inventory are uncorrelated, and a few surveys are outdated or inadequate to meet Bureau needs.

Soil survey accomplishments in California are 30, 217 acres mapped in fiscal year 2000 in the Surprise Survey Area. In fiscal year 2001, about 7,200 acres was mapped in threatened and endangered species habitat and soil survey is being initiated in the California Desert District. Colorado identified 100,000 acres mapped in the Ridgway area. Idaho BLM mapped 2,000 acres in the Clark County survey area and is digitizing soils already mapped. Montana reported 94,500 acres mapped. Nevada mapped 80,000 acres in fiscal year 2000 and will do the same in 2001 in Clark County. The Eastern White Pine soil survey has been started with a target of 200,000 acres for fiscal year 2001. The Oregon ESI crew mapped 212,000 acres in fiscal year 2000. They expect to complete field mapping for northern Lake County this year. When the documentation

and input into NASIS are completed in 2003, they will start the Malheur County survey. Utah reported 260,000 acres mapped in the Grand Staircase/Escalante area in fiscal year 2000 and propose completing 200,000 acres this fiscal year.

There are currently 36 Bureau soil scientists with none in Alaska or California and only one in some states. The majority of Bureau soil scientists are eligible to retire in the next 6 years. However, there are some promising developments. Three states have identified a new soil position to be funded with fire money, namely California, Montana and Utah. California has also identified a temporary soil position to be funded with off-highway-vehicle money. Hopefully, this indicates a new trend of multi disciplinary funding of soil positions.

The greatest soil information need is for existing soil survey information to be made available to our customers. We have some surveys where the field work was completed over 10 years ago and the surveys are still not published. We have millions of acres of uncorrelated surveys that need to be correlated and information made available. We have a large backlog of surveys that need to be digitized. Automated soil information for surveys that are not SSURGO certified surveys needs to be made available.

Soil surveys need to be completed where they provide vital support for critical resource management issues. The California Desert is one of the biggest gaps we have, and the start of that survey is encouraging.

The Bureau hopes to work with NRCS in testing and refining new mapping technology. The California Desert survey is where we plan to put our emphasis for this effort.

Bureau soil scientists need to be fully operational in the use of the Soil Data Viewer and other automated software to access soil information. They also need to be able to overlay and otherwise integrate this information with land status, allotment boundaries, timber sale boundaries, and other resource themes. Thus, training in ArcView that is specific to soil information needs is needed.

Funding is woefully inadequate to meet Bureau soil needs. Creative funding and cooperative projects with our other NCSS partners is the answer to this dilemma.

In summary, the Bureau's issues are ever shifting. Soil survey information needs are increasing as soil expertise within the Bureau decreases. Thus, we need to continue working closely with our partners in the National Cooperative Soil Survey to reach our goals in the soil program.

1890's Colleges Perspective—Research and Recruitment

Richard W. Griffin, Prairie View A&M

- 17 schools located in 16 states, mainly in the South and East
- Association of Research Directors' Report—Fall, 1997, contains statistics and a biography for each university
- Compilation of campus statistics is being completed by Agricultural Economics Dept. at Texas A&M University. The report should be available next year and will provide critical data.
- Directory of State Research and Extension Agronomy contacts provides a listing of responsibility codes for each person.
- USDA/1890 Liaison Officers Digest provides excellent examples of student projects, club activities, outreach, and recruitment efforts.
- A database being developed and Internet connectivity will enhance efforts to build stronger links between soil survey and the 1890 schools.
- Association of Research Directors meetings are held every 2 years, but scientists and educators must continue to correspond between designated meetings.
- A link between USDA-NRCS workers and 1890 school key personnel is needed to foster more active cooperative work between the two groups.

Tribal Colleges—Potential Curriculum, Recruitment & Retention

Thedis Crowe, NRCS, MT; Terry Tatsey, Blackfeet College, MT; and Leslie Henry, Oglala Lakota College, SD

History of Tribal Colleges

These were created over the past 25 years with primary focus on the unique higher education needs of American Indians and in recognition of the importance of post-secondary education to:

- ✓ Tribal economic development
- ✓ cultural preservation
- ✓ sovereignty
- ✓ locations in remote rural areas that are not served by other post-secondary institutions
- ✓ students for whom higher education would otherwise be geographically or culturally inaccessible

Land Grant Policy

Morrill Act—Original Land Grant Act of 1862 & the Land Grant Act of 1890

- ✓ Established institutions of higher learning dedicated to the teachings of agriculture & the mechanical arts.

Equity in Land Grant Status Act of 1994

- ✓ Acknowledged that Tribal Colleges play a similar educational role within their reservations.
- ✓ Designated 29 Tribal Colleges as the “1994 Institutions” to be considered land grant colleges.

USDA Policy

DR 1020-6, Section 4(e)—Policies (10/22/92)

USDA officials will work with the Tribal governments and tribal high schools, colleges, & universities to encourage the development of:

- ✓ agribusiness skills
- ✓ awareness
- ✓ curriculum

USDA will share information through the exchange of technical staffs and skills.

Executive Order 13021, October 19, 1996

All departments & agencies are to develop a 5-year plan for integrating American Indian Tribal Colleges into their programs, similar to the way Historically Black Colleges & Universities and Hispanic Serving Institutions have been integrated into Federal programs.

USDA will ensure that Tribal Colleges are more fully recognized as accredited institutions and have access to opportunities afforded other institutions of higher learning and that Federal agencies are committed to Indian institutions on a continuing basis.

MOU Representing the “1994 Institutions,” February 3, 1998

Dan Glickman, Secretary of Agriculture

Veronica Gonzales, Exec. Director of AIHEC

Dedicated to establishing programs to ensure that tribally controlled colleges & universities & American Indian communities equitably participate in USDA employment, programs, services, and resources.

Potential—

1. Begins with outreach
2. Technical & educational assistance
3. TA w/ curriculum development & teaching course work
4. Recruitment
5. Coop students, employment
6. Partnerships
7. Research & special projects

Benefits—

1. Broaden technical knowledge & management abilities of American Indian students in agriculture & natural resources
2. Outreach to historically underserved communities & rural operators
3. Improved access to educational opportunities & educational benefits to limited resource/socially disadvantaged populations

NCSS Special Reports

The Soil Survey and Hazards Planning—A Colorado Front Range User's Perspective

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Abstract

“Smart” development or growth is a growing concern among local governments and citizens who have come to understand the negative effects of unplanned growth. Poorly planned urban growth can leave communities with strained services and very high costs. Communities are faced with accommodating growth while protecting community character and fostering a wise use of limited natural and financial resources.

A main principle of “smart” development is the efficient use of land and natural resources. One of the “smart” growth strategies used by communities is the adoption of a comprehensive or master plan. These plans outline a community’s short- and long-range goals and form the basis for land use decisions. Master plans often contain policies and land use recommendations that are based on studies of natural resources and hazards. Examples of Front Range geological hazards are presented.

Soil surveys contain a great deal of general planning information that is useful in the development of master plans. For example, soil surveys can be used to identify areas with expansive soils, unstable slopes, and highly erodible soils. Soil surveys contain information on the physical, chemical, and engineering properties of soils that can be useful in making land use and infrastructure planning decisions. However, much of the soil information contained in a soil survey is presented in a way that makes it difficult for the average planner to understand and use effectively. Mention shrink-swell potential, linear extensibility or K factors and a “glazed over” look will soon appear on the faces of many planners.

In order for soil information to be more widely used in land use planning and understood by a greater variety of customers, it must be presented in a simple, easy-to-understand format. The Natural Resources Conservation Service has digitized and attributed many soil surveys, making it easy to generate specific GIS attribute maps that are useful in comprehensive planning and are easily understood by planners, developers, and citizens.

Examples of soil survey attribute maps that have been included in community or regional master plans are presented. The maps include: highly erodible soils, potentially unstable slopes, and expansive soils. The methods used to generate the maps are discussed, as are examples of land use policies on natural resources and hazards included in a master plan.

Introduction

Master plans are a community's vision on how it sees itself now and how it would like to be seen in the future. It is an important document because it typically forms the basis for all future land use decisions in a community. In making recommendations for future land uses, most master plans indicate environmental constraints or the capacity of the land to support future development. In addition, Colorado has several state laws that allow local communities to regulate development of critical lands using a variety of land use tools.

The Colorado Geological Survey (CGS) helps local communities with geologic hazard identification, mapping, mitigation, and land use planning. CGS has found that soil surveys can be helpful tools in planning that involves natural hazards. The soil survey is also misused as a site-specific soil investigation and underused as a tool in comprehensive planning.

The purpose of this paper is to briefly describe some of the geological hazards along the Front Range and to give examples of how the soil survey can be used in the identification of natural hazards and the planning associated with those hazards.

Examples of Geological Hazards¹

Rockfall

Rockfall is the falling of a newly detached mass of rock from a cliff or down a very steep slope. Rocks in a rockfall can be of any dimension, from the size of baseballs to houses.

Characteristics

- Rockfalls are the fastest type of landslide and occur most frequently in mountains or other steep areas during early spring, when there is abundant moisture and repeated freezing and thawing. The rocks may free-fall or carom down in an erratic sequence of tumbling, rolling and sliding. The plummeting of a large number of rocks at high velocity is called a rock avalanche.
- Rockfalls are caused by the loss of support from underneath or detachment from a larger rock mass. Ice wedging, root growth, or ground shaking, as well as a loss of support through erosion or chemical weathering, may start the fall.

Consequences

- Rockfalls can demolish structures and kill people. Rocks falling on highways may strike vehicles, block traffic, cause accidents, and sometimes damage the road. Minor but costly is the work of clearing highways and borrow ditches in rockfall areas. Any structure in the path of a large rockfall is subject to damage or destruction.

¹ Shelton, D.C., and D. Prouty. *Nature's Building Codes, SP 12*. 1979. Colorado Geological Survey.

Land Use

- The most appropriate land use in rockfall hazard areas is open space. Land development beneath or within rockfall areas should include evaluation of the hazards during the planning stage so structures can be located where rockfall damage is minimized. Unstable rocks can be removed or stabilized at considerable cost. In many cases, periodic rock removal is necessary.

Landslides

Landslides are the downward and outward movement of slopes composed of natural rock, soils, artificial fills, or combinations thereof. Common names for landslide types include slump, rockslide, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep.

Characteristics

- Landslides move by falling, sliding, and flowing along surfaces marked by differences in soil or rock characteristics. A landslide is the result of a decrease in resisting forces that hold the earth mass in place and/or an increase in the driving forces that facilitate its movement.
- The rates of movement for landslides range from tens of feet per second to fractions of inches per year. Landslides can occur as reactivated old slides or as new slides in areas not previously experiencing them.
- Areas of past or active landsliding can be recognized by their topographic and physical appearance. Areas susceptible to landslides but not previously active can frequently be identified by the similarity of geologic materials and conditions to areas of known landslide activity.

Consequences

- Railroads, highways, homes, and entire communities are lost to landslides that demolish and/or bury them. In Colorado, the 19th century mining camp of Brownsville just west of Silver Plume is buried beneath a rain-triggered landslide that became a debris flow. It is now under Interstate 70. Landslides occur commonly throughout Colorado.

Land Use

- Mitigation techniques can be quite costly, particularly for large landslide areas, and are often used only as a last resort or to protect expensive structures. Even then, they may be temporary and in the end ineffective. In general, recognition and avoidance of landslide areas with all structural land uses are desirable. Significant earth moving or structural use of the land always justifies a thorough analysis of the landslide potential before construction.

Debris Flows and Mudflows

A mudflow is a mass of water and fine-grained earth materials that flows down a stream, ravine, canyon, arroyo, or gulch. If more than half of the solids in the mass are larger than sand grains, as are rocks, stones, and boulders, the event is called a debris flow.

Characteristics

- Debris flows and mudflows are a combination of fast-moving water and a great volume of sediment and debris that surges downslope with tremendous force. The consistency is like that of pancake batter. These flows are similar to flash floods and can occur suddenly without time for adequate warning. When the drainage channel eventually becomes less steep, the liquid mass spreads out and slows down to form a part of a debris fan or a mudflow deposit. In the steep channel itself, erosion is the dominant process as the flow picks up more debris. A drainageway may have several mudflows a year, or none for several years or decades. Debris flows and mudflows are common events in the steep terrain of Colorado and vary widely in size and destructiveness.

Consequences

- Mudflows and debris flows ruin substantial improvements with the force of the flow itself and the burying or erosion of them by mud and debris. The heavy mass pushes in walls, removes buildings from foundations, fills in basements and excavations, and sweeps away cars and other large objects. Boulders and trees swept along by the muddy mass demolish buildings and utilities.

Land Use

- In most instances very little can be done to mitigate the mudflow process in the channel itself. Recognizing natural mudflow areas and avoiding them can prevent property damage. In some cases, revegetating or reinforcing unstable slopes can reduce the effect of large volumes of moving water upon them. A series of check dams or other storm-drainage management practices may be considered in some cases. Geologic investigations can identify areas of mudflow potential and serve as a guideline for development of mitigation plans.

Wildfire Hazards and Planning

Because of recent wildfires and subsequent flooding, there is an increased awareness of the debris flow and mudflow hazards and excessive sedimentation that can occur after a wildfire. After the Hi Meadow and Bobcat fires, the Colorado Geological Survey and USGS evaluated fire areas for potential hazards and structures that might be at risk. The soil survey was used in the evaluation of post fire hazards. Soil erodibility and the depth of soil were factors considered in the flooding and debris flow hazard assessments. The

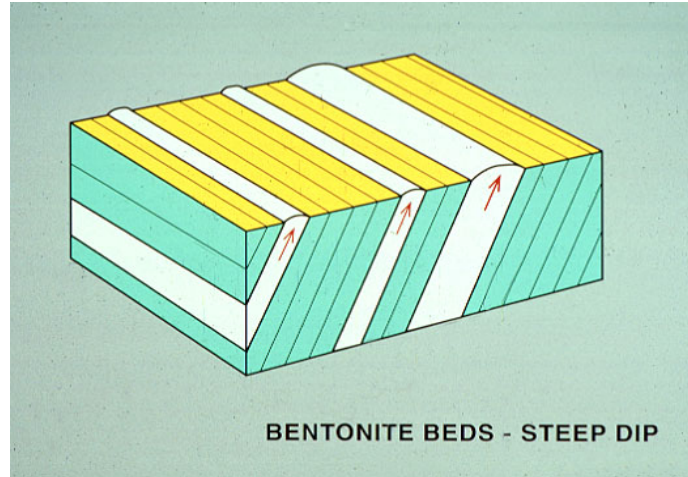
map was used by emergency management agencies in planning evacuation routes and in planning post fire rehabilitation efforts.

Highly Erodible Soils

As land becomes more expensive, there is increased pressure to develop sites with fragile soils and steep slopes. What used to be considered undevelopable land is now marketed as view lots. A high percentage of Front Range soil contains a high fraction of silt and clay. The erodibility of such soil is often greatly underestimated. Engineers often use soil survey estimates of soil erodibility without considering how site construction affects erodibility. For example, significant grading can remove all the organic matter from soil and expose weathered bedrock, increasing runoff and soil erodibility. The soil survey is often misused as a detailed evaluation of site-specific conditions rather than a general planning tool as intended.

Expansive Soil

The expansive clays of the Front Range cause

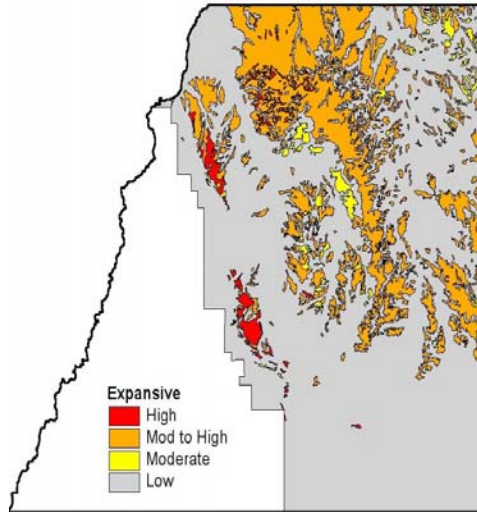


Many common expansive soil mitigation measures, such as a drilled pier foundation, do not perform well in steeply dipping expansive bedrock. Pier foundations are designed to be placed below expansive soils into stable bedrock. However, the bedrock is prone to deep moisture penetration and is not stable. Some steeply dipping bedrock layers can contain seams of highly swelling bentonite that increase the potential for severe differential movement.

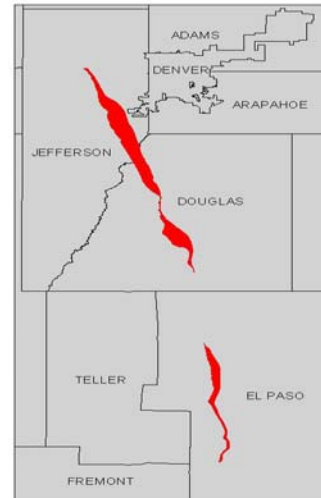
The Soil Survey and Hazards Planning—Douglas County, Colorado

Expansive Soils and Bedrock

Homeowners in Douglas County have incurred millions of dollars in damage due to expansive soils and bedrock. Heaving bedrock underlies a large area of mostly undeveloped land in Douglas County. The Douglas County Master Plan was amended in 2001 and now includes policies concerning development in areas with expansive soils and steeply dipping bedrock. The plan recommends that development be avoided or limited in areas with steeply dipping bedrock and highly expansive soils. Following is an expansive soils map of Douglas County that is used as a general planning tool and part of the master plan. The map is based upon linear extensibility data obtained from the soil survey.

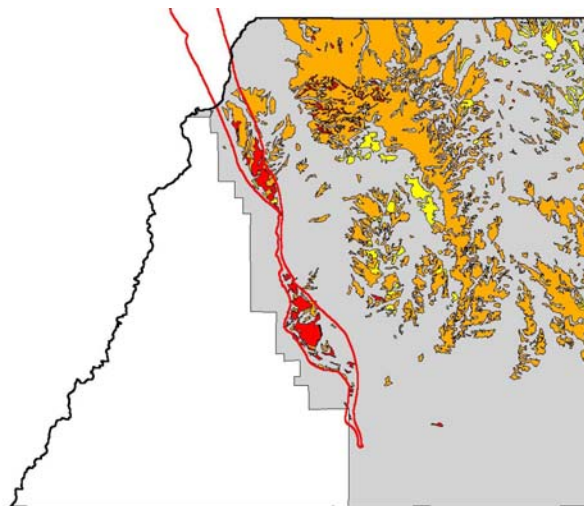


Douglas County expansive soils map derived from soil survey.



Map of Front Range steeply dipping bedrock.

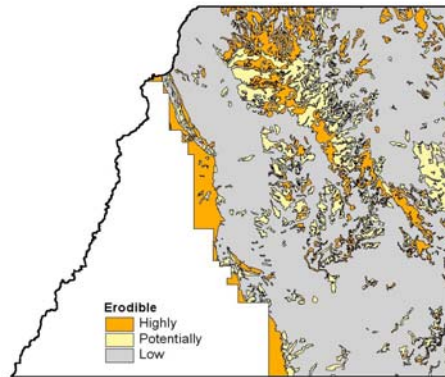
As discussed previously, steeply dipping bedrock is a geological hazard where individual layers of bedrock have different swell potentials. One would assume that the soil survey would not be of much use in the identification of such a distinct geological hazard. However, when we lay the steeply dipping bedrock map (tilted or upturned sedimentary bedrock has dip angles of greater than 30 degrees and expansive clays) shown above over the expansive soils map derived from the soil survey, we find that the two maps correlate well. The soil survey appears to be a useful planning tool for the identification of steeply dipping bedrock.



Map of steeply dipping bedrock hazards overlaid onto expansive soils map derived from soil survey.

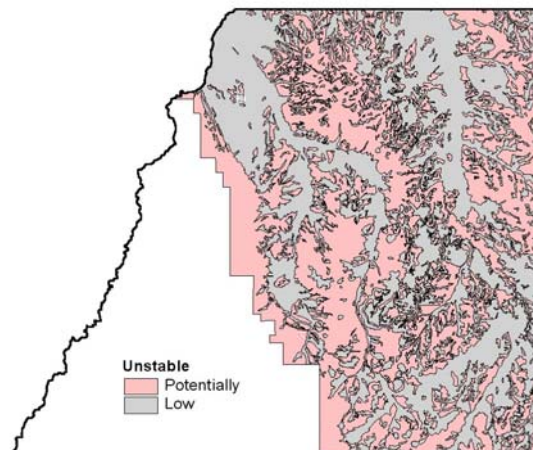
Highly Erodible Soils

The master plan contains criteria for development in areas with highly erodible soils, such as requiring special mitigation or studies. The following map is based primarily on erodibility factors identified in the soil survey. It gives planners a way to identify areas where special mitigation or studies may be required.



Unstable Slopes

Douglas County does not contain many large deep-seated landslides; however, there are many areas where shallow soil slippage occurs. Disturbing highly erodible soils on the steeper slopes often results in shallow slope failures. The soil survey identifies the soil types and conditions prone to shallow failures. The following unstable slope map is based on soil erodibility factors and slope.



Summary

The soil survey is a valuable resource for urban planners that is often underused or misused. The information contained in the soil survey must be presented in a format that is easily understood by planners and the public. Soil and natural resource professionals

can be an invaluable resource in helping local communities and planners with master planning efforts.

As professionals, we should work with planners and local officials to understand their needs and how the soil survey can help planning efforts. We should attend local land use hearings and participate in community planning processes. The soil survey is an invaluable tool in natural resource and hazard planning. As communities deal with growth and other planning issues, it is important that resources, such as the soil survey, be readily available and usable by a variety of customers.

References

1. Draft Douglas County Master/Comprehensive Plan. 2001, Douglas County, Castle Rock, CO.
2. Finstad, G., *A Guide for Reviewing Local Land Use and Development Plans in Colorado*. 2000. United States Department of Agriculture, Natural Resources Conservation Service, Lakewood, CO.
3. Noe, D., C. Jochim, and P. Roger, *A Guide to Swelling Soil for Colorado Homeowners and Homebuyers—Special Publication 43*. 1997. Colorado Geological Survey, Denver, CO.
4. Shelton, D., and D. Prouty, *Nature's Building Codes Geology and Construction in Colorado*. 1979. Colorado Geological Survey, Denver, CO.

NRCS Activities in Federal Geospatial Coordination Efforts and the FGDC

Jim Fortner

Soil Scientist, NSSC, NRCS

Federal Coordination Bodies Having a Geospatial Component or Focus

There are several organizations that focus on geospatial data, including the following:

- FGDC—Federal Geographic Data Committee
- OGC—Open GIS Consortium
- DE—Digital Earth
- National Atlas
- National Map
- CAC—Civilian Applications Committee
- CEOS—Committee on Earth Observation Satellites
- GDIN—Global Disaster Information Network
- Geodata Initiative
- E-Gov/G-Gov
- IGEB - Interagency GPS Executive Board
- NAPP/NDOP—National Aerial Photography Program, National Digital Ortho Program
- NDEP—National Digital Elevation Program
- OMB-I Teams—Office of Management and Budget, Infrastructure Team initiative

During this presentation, I will concentrate on the FGDC and NRCS's involvement with that group.

What is the FGDC?

- Excerpt from www.fgdc.gov:
 “The Federal Geographic Data Committee (FGDC) is an interagency committee organized in 1990 under OMB Circular A-16 that promotes the coordinated use, sharing, and dissemination of geospatial data on a national basis.”
- ✓ The FGDC is composed of representatives from 17 Cabinet-level and independent Federal agencies.
- ✓ The Steering Committee sets high-level strategic direction for the FGDC as a whole.
- ✓ The Coordination Group advises on the day-to-day business of the FGDC.
- ✓ The FGDC Secretariat staff (USGS) provides staff support for FGDC subcommittees.
- Co-chaired by Dept. of Interior and OMB
- The FGDC subcommittees are organized by data themes.
- Working groups play a crosscutting role, dealing with issues that span many subcommittees.

Why Should Federal Agencies Participate?

- FGDC coordinates the activities of the National Spatial Data Infrastructure, or NSDI, which was established in 1994 by Executive Order 12906. Federal agencies are encouraged/directed by this executive order to participate.
- NSDI is defined as *“the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community.”*
- By sharing these resources, it is anticipated that the cost of data production will be reduced, quality will be improved, data will be more accessible, and partnerships between all interested parties will be mutually beneficial.

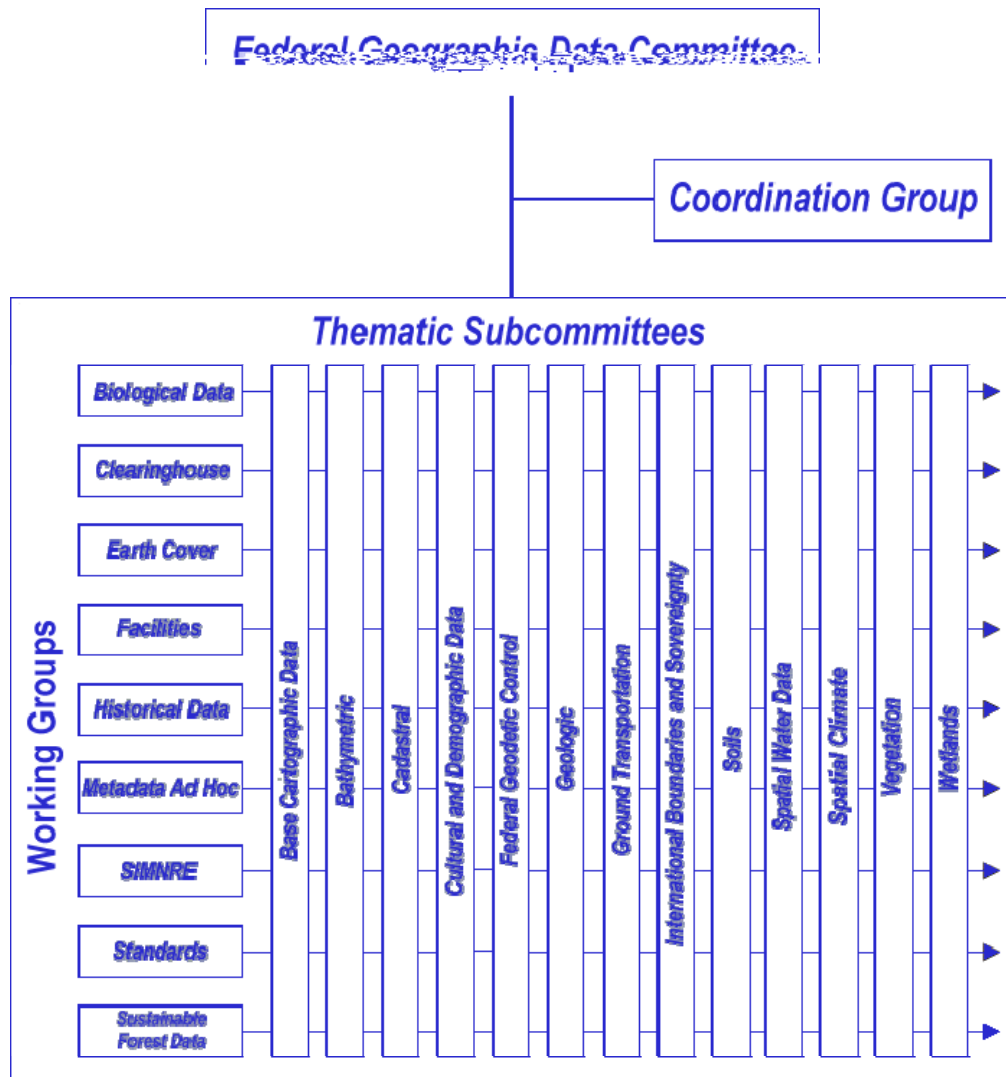
FGDC Federal Members:

- | | |
|---|---|
| ➤ Department of Agriculture | ➤ Department of Transportation |
| ➤ Department of Commerce | ➤ Environmental Protection Agency |
| ➤ Department of Defense | ➤ Federal Emergency Management Agency |
| ➤ National Imagery & Mapping Agency | ➤ Library of Congress |
| ➤ Department of Energy | ➤ National Archives and Records Administration |
| ➤ Department of Health and Human Services | ➤ National Aeronautics and Space Administration |
| ➤ Department of Housing and Urban Development | ➤ National Science Foundation |
| ➤ Department of the Interior | ➤ Tennessee Valley Authority |
| ➤ Department of Justice | |
| ➤ Department of State | |

➤ **Working Groups**

- ✓ Biological Data
- ✓ Earth Cover
- ✓ Sample Inventory and Monitoring of Natural Resources and Environment (SIMNRE)* Standards

* NRCS chairs the group.



Soil Data Subcommittee

- Has government-wide responsibility to coordinate the development of a National Soil Digital Spatial Data Infrastructure to promote the collection, use, sharing, and dissemination of soil data pertinent to the needs of the Nation in order to avoid duplication and waste.
- Monitors the types of soil data collected and the coding schemes used.

- Ensures that standards of accuracy and currentness are established for these data and that the standards are used throughout the Federal establishment.
- Exchanges information on technological improvements for collecting these data.
- Encourages the States to accept the standards and specifications for digital exchange of these data.
- Collects and reports on the requirements for digital spatial soil data.

- Membership
 - ✓ NRCS, Chair—Jim Fortner
 - ✓ USFS
 - ✓ BLM
 - ✓ USGS
 - ✓ US Fish & Wildlife
 - ✓ TVA
 - ✓ EPA
 - ✓ ARS
 - ✓ Office of Surface Mining
 - ✓ National Biological Survey
 - ✓ NASA
 - ✓ DOD

Soil Geographic Data Standard

- The Soil Data Subcommittee developed the Soil Geographic Data Standard, which was reviewed and endorsed by the FGDC in September 1997. Prior to endorsement by the FGDC, this standard was reviewed and endorsed by the NCSS Standards Committee.
- The Soil Geographic Data Standard is one of 16 standards that have been reviewed and endorsed by the FGDC member agencies.
 - ✓ It standardizes the names, definitions, ranges of values, and other characteristics of soil survey **map** attribute data developed by the National Cooperative Soil Survey (NCSS).
 - ✓ Is available for download at http://www.fgdc.gov/standards/status/sub2_2.html

Soil Data Subcommittee

- The following have been identified as items for the subcommittee to pursue:
 - ✓ Reactivate/re-energize the group
 - ✓ Maintain/update Soil Geographic Data Standard
 - ✓ Develop point soil data standard
 - ✓ Develop soil digitizing standard
 - ✓ Facilitate the development of a geomorphic description standard. NRCS and USFS personnel have been in negotiations for the past 2 or 3 years in an effort to develop a standard list of geomorphic terms to be used in soil survey. There is interest in elevating this to the FGDC level to develop a national standard list. This will likely get the involvement of other agencies, such as USGS.

Examples of FGDC Activities

- Spatial Water Subcommittee
 - ✓ Defining standards for linear water features—stream networks etc.
 - ✓ Developing techniques to automate watershed delineation.
- Earth Cover Working Group
 - ✓ Looking at applicability of Multi-Resolution Land Characteristics (MRLC) classification methods and possible use for Earth Cover.
- Spatial Climate Subcommittee
 - ✓ Development of metadata elements to enhance climate data descriptions

FGDC Endorsed Standards

- Content Standard for Digital Geospatial Metadata (version 2.0)
- Content Standard for Digital Geospatial Metadata, Part 1: Biological Data Profile
- Spatial Data Transfer Standard (SDTS)
- Spatial Data Transfer Standard (SDTS), Part 5: Raster Profile and Extensions
- Spatial Data Transfer Standard (SDTS), Part 6: Point Profile
- SDTS Part 7: Computer-Aided Design and Drafting (CADD) Profile
- Cadastral Data Content Standard
- Classification of Wetlands and Deep Water Habitats
- Vegetation Classification Standard
- Soil Geographic Data Standard
- Geospatial Positioning Accuracy Standard, Part 1, Reporting Methodology
- Geospatial Positioning Accuracy Standard, Part 2, Geodetic Control Networks
- Geospatial Positioning Accuracy Standard, Part 3, National Standard for Spatial Data Accuracy
- Content Standard for Digital Orthoimagery
- Content Standard for Remote Sensing Swath Data
- Utilities Data Content Standard

FGDC Standards With Public Review Complete, but Not Yet Approved

- Facility ID Data Standard
- Geospatial Positioning Accuracy Standard, Part 4: Architecture, Engineering Construction and Facilities Management
- Content Standard for Framework Land Elevation Data
- Metadata Profile for Shoreline Data
- Hydrographic Data Content Standard for Coastal and Inland Waterways
- Digital Geologic Map Symbolization
- Geospatial Positioning Accuracy Standard, Part 5: Standard for Hydrographic Surveys and Nautical Charts

FGDC Standards in Public Review Process

- Address Content Standard
- Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata

- NSDI Framework Transportation Identification Standard U.S. National Grid for Spatial Referencing

FGDC Standards in Draft Stage

- Earth Cover Classification System
- Encoding Standard for Geospatial Metadata
- Geologic Data Model
- Governmental Unit Boundary Data Content Standard
- Biological Nomenclature and Taxonomy Data Standard

FGDC Standards in Proposal Stage

- Riparian Mapping Standard

Future FGDC Activities

- I-Teams—OMB effort will help coordinate developers of Framework data at the local level.
- Framework—Greater efforts will be placed on the development of the seven key layers by both private and public sector
- Public/Private Partnerships—A greater level of cooperation will be evident between the two sectors.
- Local players—Data developers at the local level will play an increasingly important role as users demand higher resolution data.
- Support—As data availability increases, demand for application and integration support will increase.
- Applications—Users will continue to demand increasingly sophisticated and friendly applications. As users become further removed from raw data, increased attention will be needed to ensure quality and accuracy of metadata.

Additional Information on Geospatial Activities May Be Found at These Web Sites:

- FGDC: www.fgdc.gov
- OGC: www.opengis.org
- GDIN: www.gdin-international.org/
- Digital Earth: www.digitalearth.gov
- Geodata Initiative: www.geoall.net/
- I-Teams: www.fgdc.gov/I-Team.html
- National Map: nationalmap.usgs.gov/
- National Atlas: www-atlas.usgs.gov
- NDEP: edcnts12.cr.usgs.gov/ned/
- IEGB: www.igeb.gov/

NRCS contacts

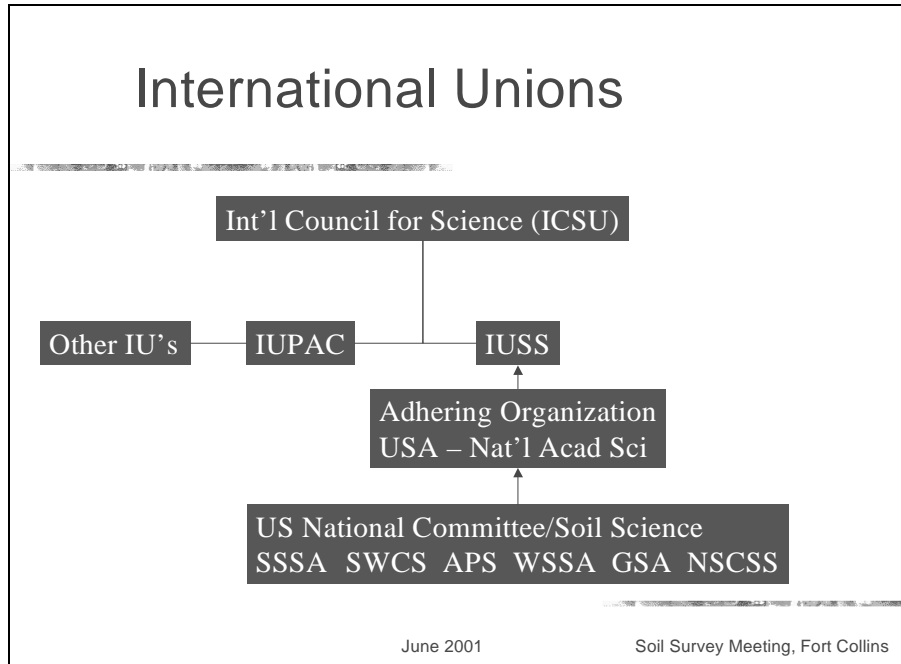
- FGDC/Soil-related information:
 - ✓ Jim Fortner (402) 437-5755, or email jim.fortner@usda.gov
- General FGDC-related information:
 - ✓ Christine Clarke (301) 504-2267, or email christine.clarke@usda.gov

SSSA and IUSS Strategy for the Future

Lee Sommers, Colorado State University

Representative to the IUSS for 2006 World Soil Congress

International Unions



IUSS Scientific Structure

1. Divisions
2. Commissions
3. Working Groups

Officers

- ✓ President and Vice President
- ✓ Appointed by the host country

1998-2002 Thailand

2002-2006 USA

Divisions of IUSS

Division 1. Soil in Space and Time

- C1.1 Soil Morphology
- C1.2 Soil Genesis
- C1.3 Soil Geography
- C1.4 Soil Classification

Division 2. Soil Properties and Processes

- C2.1 Soil Physics
- C2.2 Soil Chemistry
- C2.3 Soil Biology
- C2.4 Soil Mineralogy

Division 3. Soil Use and Management

- C3.1 Soil Evaluation & Land Use Planning
- C3.2 Soil & Water Conservation
- C3.3 Soil Fertility & Plant Nutrition
- C3.4 Soil Engineering & Technology
- C3.5 Soil Degradation Control, Remediation, and Reclamation

Division 4. The Role of Soils in Sustaining Society and the Environment

- C4.1 Soils and the Environment
- C4.2 Soils, Food Security, and Human Health
- C4.3 Soils and Land Use Change
- C4.4 Soil Education and Public Awareness
- C4.5 History, Philosophy, and Sociology of Soil Science

IUSS Officers

Division Chair

- ✓ Elected from non-host country (U.S. excluded for 2006)
- ✓ Recommended by Exec. Comm. & USNC/Soil Science
- ✓ Ratified by President, National Academy of Science
- ✓ Direct scientific program
- ✓ Member of IUSS Council
- ✓ Member of WCSS International Scientific Subcommittee

Division Vice Chair

- ✓ Selected by host country (U.S. for 2006)
- ✓ Serve on WCSS Program Subcommittee
- ✓ Serve on WCSS Editorial Subcommittee

Division Secretary

- ✓ Selected by host country (U.S. for 2006)
- ✓ Minutes and communications
- ✓ Member of WCSS Editorial Subcommittee

Commissions

- ✓ Nominations followed by election at WCSS
- ✓ All scientists eligible
- ✓ Officers—Chair, Vice Chair, Secretary
- ✓ Working Groups
- ✓ Elected at WCSS
- ✓ All scientists eligible

Organizing for the 18th WCSS—Executive Committee

- ✓ Don Sparks, President Elect IUSS
- ✓ Gary Petersen, Vice President Elect IUSS

Co-Chairs of Organizing Committee

- ✓ Larry P. Wilding, Texas A&M
- ✓ Lee E. Sommers, Colorado State Univ.

Chairs of Subcommittees (10)

SSSA Headquarters staff as ex officio

Subcommittees for 18th WCSS

1. International Scientific
2. Program
3. Editorial
4. Professional Tours
5. Local Arrangements
6. Exhibits
7. Special Events
8. Fundraising
9. Advertising and Public Relations
10. Budget and Finance

Program Development

2002—Officers installed in Bangkok

2002-2004—Symposia and program topics proposed

2003—First call for papers

2004—Inter Congress meeting held in Philadelphia, symposia finalized

2005—Papers due and Editorial Committee conducts review.

2006—Program is published in multiple formats.

Action Items!

- Nominate/volunteer for Commission Chair, Vice Chair, Secretary.
- Nominate/volunteer for Subcommittee chair or member.
- Professional tours require planning in near future.

Global Land Condition Database

Hari Eswaran and Paul Reich (USDA, Natural Resources Conservation Service, PO Box 2890, Washington DC 20013) and Danielius Pivoriunas (Institute of Botany, Vilnius, Lithuania)

**18th World Congress of Soil Science—Theme
Frontiers of Soil Science: Technology and the Information Age
Philadelphia, PA
July 10-15, 2006**

The World Soil Resources

The World Soil Resources (WSR) is dedicated to collaborating with country institutions to help manage and conserve their natural resources, improve their abilities to attain sustainable agriculture, and enhance their capabilities to address problems of food security, income generation, and the environment. During the last decade we have developed databases that permit us to analyze global and regional soil conditions in an empirical manner.

One of the major thrusts of the World Soil Resources (WSR) office since its inception in 1980 was to develop a global database on soils. The reason for this was to provide the database to support its efforts to refine Soil Taxonomy (the U.S. system of soil classification) for its better use and application in the Tropics. With the development of Decision Support Systems by a project of the University of Hawaii supported by the U.S. Agency for International Development, called the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), WSR was requested to provide the soils database for their DSSAT (Decision Support System for Agrotechnology Transfer). By the late eighties, the database was becoming increasingly in demand by not only those persons working with crop simulation models but also by those working on Global Climate Change and all its ramifications. Both these modeling groups wanted the major soils of the world characterized, and WSR set this as its goal. Towards the end of the eighties, development of spatial databases became feasible, and WSR immediately equipped itself to meet this challenge. Many international agencies and organizations rely on WSR for its global database and as such WSR has become the *de facto* custodian of global soils data. WSR is a part of the International Geosphere Biosphere Program of the International Council of Scientific Unions and is consulted for information on soils of the world.

With declines and uncertainties of the budgetary situation in the last few years, much of the work of WSR is confined to developing spatial databases. Enhancement of the pedon database requires sampling in different countries; however, this activity is currently terminated due to lack of funds. This report describes the status of the database effort and gives examples of our products.

Global Databases

Database Management System

WSR is developing the Biophysical Resource Appraisal Support System (BRASS). In the initial design of the prototype BRASS, the input data are identified with two types of databases: weather and soil. Eventually land cover and land use will be added. As a user chooses the event, location, and spatial scale for his or her decision, the chosen area is categorized according to international classifications identified with each of the database types. As part of the initial design of the prototype BRASS, any current or future information source could be easily incorporated into its structure with little change to the user interface. By adhering to such a design, a user can continue to use the same BRASS interface program as new information sources and models are added and old sources are modified or deleted. This approach accelerates the transfer of new information from the field or lab with a minimal amount of additional training on the part of the user.

An operational prototype version of BRASS is being developed. For the moment it consists of climatic data from 24,000 stations around the world, a digitized soil map of the world, the pedon database of WSR, and some of the Global Climate Change (GCC) models that are available. The BRASS database has been used to make some global and regional assessments, as will be indicated later. We need to continue the development of this database to realize its full capabilities. However, development is now terminated due to lack of funds.

Climate database

The climate database in BRASS is linked to a model, which computes the following:

- soil moisture regimes
- soil temperature regimes
- length of growing season with beginning and end
- moisture stress severity index
- temperature stress severity index
- climate stress severity index
- soils according to FAO legend or Soil Taxonomy

Pedon Database

The National Soil Survey Center of USDA, NRCS, maintains the Pedon database, which contains descriptions and data for about 20,000 pedons, of which about 1,500 are from outside the U.S. The unique feature of this database is that all the soils were described, sampled, and analyzed by one organization—NRCS—and as such it is the world's largest and most reliable database. The database is in great demand, and so the National Soil Survey Center has developed a CD-ROM with all the data available until 2000. During the last 2 years, the sampling program is significantly reduced due to lack of funds. We used to sample soils from 2 to 3 countries each year. During the sampling, we normally

collect more samples than we need for our soil characterization program. The remaining samples are stored. The stored samples are provided on request for special studies by universities or other institutions. Archived samples are also used for methods development. The methods of soil analysis of the National Soil Survey Laboratory are now world standards.

Derived-Data Database

Many users do not need to use all the data contained in our database. They require selected data, which serve as inputs in their GIS or simulation models. We maintain a database of frequently required properties that include:

- soil carbon
- soil nitrogen
- available water-holding capacity
- bulk density
- soil nutrients (total and available)
- pH

Spatial databases—GIS

We have the capability to process and analyze geographic data using PC-ARC/INFO and IDRISI. We maintain a library of digitized materials. To maintain this library, we try to acquire digitized materials from around the world. These digitized materials are normally available to others only when the institution that provided us with the materials has given us the permission to distribute. In such instances, we refer the request to the original institution.

We have generated many maps on request using our spatial databases. A GIS coverage of these maps is normally not available, and we can provide digital images and hard copies. Over the last few years, we have made some specific studies related to the application of GIS. Four examples are given later. Examples of these maps are on our Web site (www.nhq.nrcs.usda.gov/WSR/).

Concluding Remarks

Soil database development is slow and tedious work. There is an assumption that data are available and all that is needed entry of the data into a database. Unfortunately, few data exist for the kinds of analysis needed. Many developing countries have few or no data, requiring us to make judgements. Such assessments are always questioned. When data are available, we still have the task of validating the data and, in most cases, harmonizing the information. Quality of data and methods by which they were acquired (specifically information relating to soils) vary among countries. Database development is also a continuous process. There is no other organization in the U.S. that has the capability or perhaps the interest to develop and maintain a global database on soils. NRCS has the capability and interest to do this, and we have been very successful with the financial support provided in the past by the U.S. Agency for International Development.

OUR PUBLICATIONS WITH GLOBAL AND REGIONAL DATA

1. Eswaran, H, R. Almaraz, E. van den Berg, and Paul Reich. 1997. An assessment of the soil resources of Africa in relation to productivity. *Geoderma*, 77:1-18.
2. Eswaran, H, R. Almaraz, P. Reich, and P. Zdruli. 1997. Soil quality and soil productivity in Africa. *J. Sustainable Agric.* 10:75-94.
3. Eswaran, H, P. Reich, and F.H. Beinroth. 1997. Global distribution of soils with acidity. In: Moniz, A.Z., A.M.C. Furlani, R.E. Schaffert, N.K. Fageria, C.A. Rosolem, and H. Cantarella. "Plant-Soil Interactions at Low pH: Sustainable Agriculture and Forestry Production". *Proc. 4th. Inter. Symp. On Plant-Soil Interactions at Low pH*, Belo Horizonte, Minas Gerais, Brazil, 159-164.
4. Reich, P., M. Soekardi, and H. Eswaran. 1997. Carbon stocks in soils of Indonesia. In: Lal, R., J. Kimble, and R. Follett (eds.). *Soil Properties and their Management for Carbon Sequestration*. USDA, Natural Resources Conservation Service, Lincoln, NE. 121-127.
5. Eswaran, H and J. Dumanski. 1998. Land degradation and sustainable agriculture: A global perspective. In: Bhushan, L.S., I.P. Abrol, and M.S. Rama Mohan Rao (Eds.). *Proc. 8th Intl. Soil Conserv. Conf. Publ. Indian Assoc. Soil and Water Conservationists*, Dehra Dunn, India. 1:208-226.
6. Eswaran, H. and P. Reich. 1999. Impacts of land degradation in the Mediterranean region. *Bulgarian J. of Agric. Sci.* 5:14-23.
7. Eswaran, H., P.F. Reich, J.M. Kimble, F.H. Beinroth, E. Padmanabhan, and P. Moncharoen. 1999. Global carbon stocks. In: (R. Lal, J.M. Kimble, H. Eswaran, and B.A. Stewart. eds.) *Global Climate Change and Pedogenic Carbonates*. Lewis Publishers, Boca Raton. 15-25.
8. Eswaran, H., F. Beinroth, and P. Reich. 1999. Global land resources and population supporting capacity. *Am. J. Alternative Agric.* 14:129-136.
9. Eswaran, H., F.H. Beinroth, and S.M. Virmani. 2000. Resource management domains: a biophysical unit for assessing and monitoring land quality. *Agriculture, Ecosystems and Environment*. 81:155-162.
10. Cangir, C., S. Kapur, D. Boyraz, E. Akca, and H. Eswaran. 2000. An assessment of land resources consumption in relation to land degradation in Turkey. *J. Soil and Water Conservation*. 253-259.
11. Eswaran, H., P. Reich, and F. Beinroth. 2000. Global desertification tension zones. In Press. *Intl. Soil Conserv. Conf.*, Purdue, Indiana. In Press.
12. Eswaran, H., R. Lal, and P. Reich. 2000. Land Degradation: an overview. In Press. *Proc. Intl. Conf. Land Degradation*. Khon Kean, Thailand. In Press.
13. Kunaporn, S., P. Wichaidit, T. Vearasilp, K. Hoontrakul, and H. Eswaran. 2001. An assessment of land degradation in Thailand. 2nd. International Conference on Land Degradation. Khon Kean, Thailand. CD ROM, Department of Land Development, Bangkok, Thailand. January 2001. In Press.
14. Beinroth, F.H., H. Eswaran, and Paul Reich. 2001. Land quality and food security in Asia. 2nd. International Conference on Land Degradation. Khon Kean, Thailand. CD ROM, Department of Land Development, Bangkok, Thailand. January 2001. In Press.
15. Reich, P.F., S.T. Numben, R.A. Almaraz, and H. Eswaran. 2001. Land resource stresses and desertification in Africa. 2nd. International Conference on Land Degradation. Khon Kean, Thailand. CD ROM, Department of Land Development, Bangkok, Thailand. January 2001. In Press.
16. Eswaran, H. and P. Reich. 2001. An assessment of human impact on global land systems. *Ambio*. In press.

Table 1. Statistics on soils, their condition, land use, and land cover.

| LAND PROPERTY, STATE OR CONDITION | LAND | | POPULATION | |
|---|---------------------------------|--------|------------|-------|
| | AREA (million km ²) | % | MILLIONS | % |
| 1. Total ice-free land | 130.80 | 100.00 | 5,760.00 | 100 |
| 2. Kinds of soils | | | | |
| Gelisols | 11.26 | 8.6 | 22.24 | 0.40 |
| Histosols | 1.53 | 1.1 | 27.22 | 0.48 |
| Spodosols | 3.35 | 2.5 | 92.63 | 1.65 |
| Andisols | .912 | 0.7 | 96.31 | 1.71 |
| Oxisols | 9.81 | 7.5 | 219.33 | 3.91 |
| Vertisols | 3.16 | 2.4 | 309.41 | 5.51 |
| Aridisols | 15.70 | 12.0 | 306.90 | 5.46 |
| Ultisols | 11.05 | 8.4 | 996.86 | 17.75 |
| Mollisols | 9.01 | 6.8 | 371.93 | 6.62 |
| Alfisols | 12.62 | 9.6 | 953.02 | 16.97 |
| Inceptisols | 12.86 | 9.8 | 1,099.72 | 19.58 |
| Entisols | 21.14 | 16.1 | 892.28 | 15.89 |
| Shifting sand | 5.32 | 4.0 | 70.59 | 1.26 |
| Rocky land | 13.08 | 9.9 | 152.88 | 2.72 |
| Glaciers, Water bodies | 10.01 | 7.7 | 4.79 | 0.09 |
| 3. ECOLOGICAL ZONES | | | | |
| Desert | | | | |
| Tropical | 4.36 | 3.16 | 122.91 | 2.14 |
| Temperate | 28.45 | 20.60 | 470.55 | 8.18 |
| Boreal | 5.57 | 4.03 | 58.36 | 1.02 |
| Mediterranean | | | | |
| Temperate | 3.59 | 2.60 | 324.88 | 5.65 |
| Boreal | 0.79 | 0.57 | 18.58 | 0.32 |
| Semi-arid | | | | |
| Tropical | 20.27 | 14.68 | 1,124.76 | 19.56 |
| Temperate | 7.32 | 5.30 | 828.90 | 14.42 |
| Boreal | 3.53 | 2.56 | 93.03 | 1.62 |
| Humid | | | | |
| Tropical | 11.28 | 8.17 | 526.77 | 9.16 |
| Temperate | 11.19 | 8.10 | 1,586.31 | 27.59 |
| Boreal | 8.73 | 6.32 | 263.46 | 4.58 |
| Perhumid | | | | |
| Tropical | 3.08 | 2.23 | 92.67 | 1.61 |
| Temperate | 1.13 | 0.82 | 156.38 | 2.72 |
| Boreal | 0.58 | 0.42 | 22.74 | 0.40 |
| Tundra | 18.42 | 13.34 | 58.87 | 1.02 |
| 4. Major Land Resources Stresses | | | | |
| Continuous low temperatures | 21.78 | 27.94 | 625.30 | 10.90 |
| Continuous moisture stress | 36.48 | 16.68 | 71.19 | 1.24 |
| Steep lands | 0.48 | 0.37 | 32.17 | 0.56 |
| Shallow soils | 7.36 | 5.64 | 544.87 | 9.50 |
| Salinity/alkalinity | 3.07 | 2.35 | 67.22 | 1.17 |
| High organic matter | 1.22 | 0.94 | 26.49 | 0.46 |
| Low water holding capacity | 3.36 | 2.58 | 89.14 | 1.55 |
| Low moisture & nutrient status | 3.46 | 2.65 | 99.16 | 1.73 |
| Acid sulfate conditions | 0.11 | 0.09 | 19.78 | 0.34 |
| High P,N & organic retention | 2.50 | 1.91 | 225.28 | 3.93 |
| Low nutrient holding capacity | 7.79 | 5.96 | 241.17 | 4.20 |
| Excessive nutrient leaching | 4.47 | 3.42 | 422.41 | 7.36 |
| Calcareous, gypseous condition | 2.47 | 1.89 | 252.43 | 4.40 |
| High aluminum | 4.06 | 3.11 | 314.04 | 5.47 |
| Seasonal moisture stress | 10.34 | 7.92 | 661.72 | 11.53 |
| Impeded drainage | 2.83 | 2.17 | 454.14 | 7.91 |
| High anion exchange capacity | 0.91 | 0.70 | 86.86 | 1.51 |
| Low structural stability | 1.37 | 1.05 | 113.35 | 1.98 |
| Seasonal low temperatures | 3.01 | 2.30 | 116.36 | 2.03 |
| Minor root restricting layer | 1.52 | 1.16 | 39.23 | 0.68 |
| Seasonal excess water | 1.36 | 1.04 | 110.32 | 1.92 |
| High temperatures | 2.51 | 1.92 | 281.39 | 4.90 |
| Low organic matter | 3.10 | 2.37 | 393.43 | 6.86 |
| High shrink/swell potential | 0.92 | 0.71 | 113.69 | 1.98 |
| Few constraints | 4.09 | 3.13 | 336.85 | 5.87 |

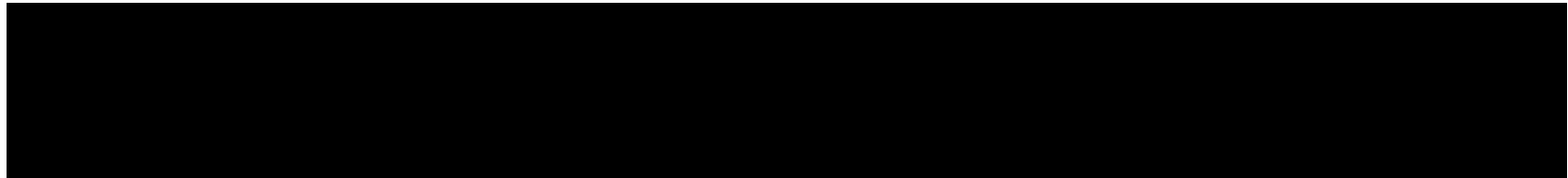
| LAND PROPERTY, STATE OR CONDITION | LAND | | POPULATION | |
|-------------------------------------|---------------------------------|-------|------------|-------|
| | AREA (million km ²) | % | MILLIONS | % |
| 5. SOIL CONDITIONS | | | | |
| Soil Acidity | | | | |
| Surface soil acidity | 37.77 | 25.90 | | |
| Slight (pH 5.5-6.5) | 12.50 | 8.57 | | |
| Moderate (pH 4.5-5.5) | 15.40 | 10.56 | | |
| High (pH 3.5-4.5) | 9.77 | 6.70 | | |
| Extremely Acid (pH <3.5) | .098 | 0.07 | | |
| Subsoil Acidity | 29.18 | 20.01 | | |
| Slight (pH 5.5-6.5) | 5.80 | 3.98 | | |
| Moderate (pH 4.5-5.5) | 13.81 | 9.47 | | |
| High (pH 3.5-4.5) | 9.47 | 6.49 | | |
| Extremely Acid (pH <3.5) | .098 | 0.07 | | |
| Water Erosion Vulnerability | 18.66 | 40.5 | | |
| Low | 5.15 | 11.2 | 1,017.12 | 17.72 |
| Moderate | 5.76 | 12.5 | 836.91 | 14.58 |
| High | 3.31 | 7.2 | 1,108.76 | 19.32 |
| Very High | 4.44 | 9.6 | 997.83 | 17.39 |
| Wind Erosion vulnerability | 17.05 | 37.0 | | |
| Low | 3.64 | 7.9 | 445.51 | 7.76 |
| Moderate | 3.74 | 8.1 | 377.76 | 6.58 |
| High | 5.92 | 12.9 | 621.00 | 10.82 |
| Very High | 3.75 | 8.1 | 671.22 | 11.69 |
| Desertification vulnerability | 44.24 | 34.0 | 2,648 | 44.0 |
| Low | 14.60 | 11.2 | 1,085 | 18.9 |
| Moderate | 13.61 | 10.5 | 915 | 15.9 |
| High | 7.12 | 5.5 | 393 | 6.8 |
| Very High | 7.91 | 6.1 | 255 | 4.4 |
| 6. LAND TYPES | | | | |
| Forest Lands | 37.78 | 27.36 | | |
| Arctic | 9.27 | 6.71 | | |
| Boreal | 4.35 | 3.15 | | |
| Temperate | 8.51 | 6.16 | | |
| Tropical | 15.65 | 11.33 | | |
| Wet soils | 18.96 | | | |
| Inland | 5.41 | 4.15 | | |
| Riparian or ephemeral | 3.10 | 2.38 | | |
| Organic (Peatlands) | 2.53 | 1.94 | | |
| Salt affected | 2.23 | 1.71 | | |
| Permafrost affected | 5.69 | 5.13 | | |
| 7. Land use & Land Cover | | | | |
| Developed (Urban) | 0.66 | 0.50 | | |
| Cultivated | 27.49 | 21.01 | | |
| Grassland | 10.82 | 8.27 | | |
| Shrubland | 15.55 | 9.67 | | |
| Shrubland/grassland | 1.26 | 0.96 | | |
| Savanna | 14.37 | 10.99 | | |
| Forest | 32.70 | 25.00 | | |
| Wetland | 1.28 | 9.79 | | |
| Desert (Barren) | 15.67 | 11.98 | | |
| Tundra | 7.51 | 5.74 | | |
| Anthropic land systems | | | | |
| Pristine | 10.25 | 7.85 | 7.57 | 0.14 |
| Minimal impact | 10.84 | 8.30 | 51.60 | 0.94 |
| Low Impact | 10.75 | 8.24 | 175.35 | 3.19 |
| Moderate Impact | 17.98 | 13.77 | 1,103.56 | 20.06 |
| High Impact | 19.93 | 15.26 | 2,255.49 | 41.00 |
| Very High Impact | 5.87 | 4.50 | 1,542.24 | 28.03 |
| Indeterminate | 57.65 | 44.15 | 365.84 | 6.65 |

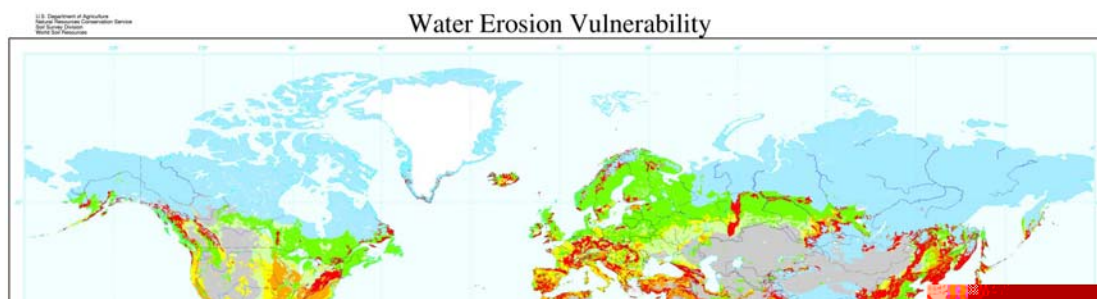
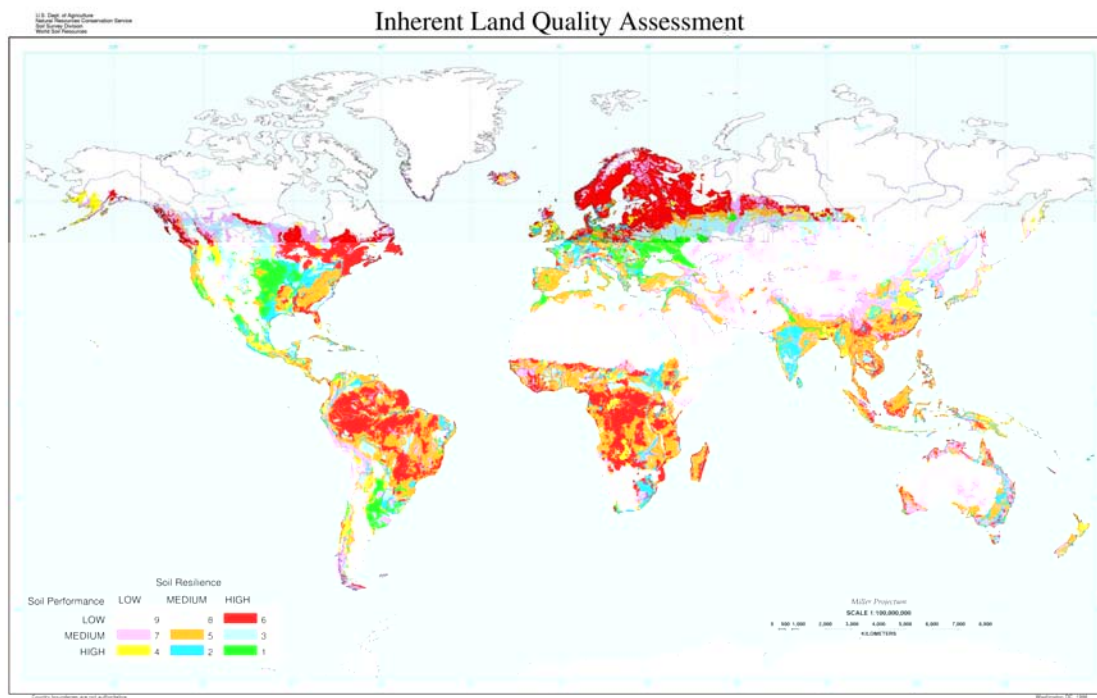
| LAND PROPERTY, STATE OR CONDITION | LAND | | POPULATION | |
|-----------------------------------|------------------------------------|-------|------------|--------|
| | AREA (million km ²) | % | MILLIONS | % |
| 8. Land Quality Class (LQC) | | | | |
| I | 4.09 | 2.96 | 336.85 | 5.87 |
| II | 6.53 | 4.73 | 788.51 | 13.74 |
| III | 5.88 | 4.26 | 265.92 | 4.63 |
| IV | 5.11 | 3.70 | 654.34 | 11.40 |
| V | 21.35 | 15.46 | 1,650.61 | 28.77 |
| VI | 17.22 | 12.47 | 674.53 | 11.76 |
| VII | 11.65 | 8.44 | 638.59 | 11.13 |
| VIII | 36.48 | 26.42 | 103.36 | 1.80 |
| IX | 22.26 | 16.12 | 625.30 | 10.90 |
| 9. Population Supporting Capacity | | | BILLIONS | |
| Low Input Situation | | | | |
| I | | | 0.982 | 17.05 |
| II | | | 1.371 | 23.80 |
| III | | | 0.884 | 15.35 |
| IV | | | 0.460 | 7.99 |
| V | | | 1.601 | 27.80 |
| VI | | | 0.861 | 14.95 |
| Medium Input Situation | | | | |
| I | | | 1.472 | 25.56 |
| II | | | 1.959 | 34.01 |
| III | | | 1.178 | 20.45 |
| IV | | | 0.689 | 11.96 |
| V | | | 2.135 | 37.07 |
| VI | | | 1.292 | 22.43 |
| High Input Situation | | | | |
| I | | | 2.45 | 42.53 |
| II | | | 2.351 | 40.82 |
| III | | | 2.695 | 46.79 |
| IV | | | 1.610 | 27.95 |
| V | | | 6.405 | 111.20 |
| VI | | | 4.305 | 74.74 |

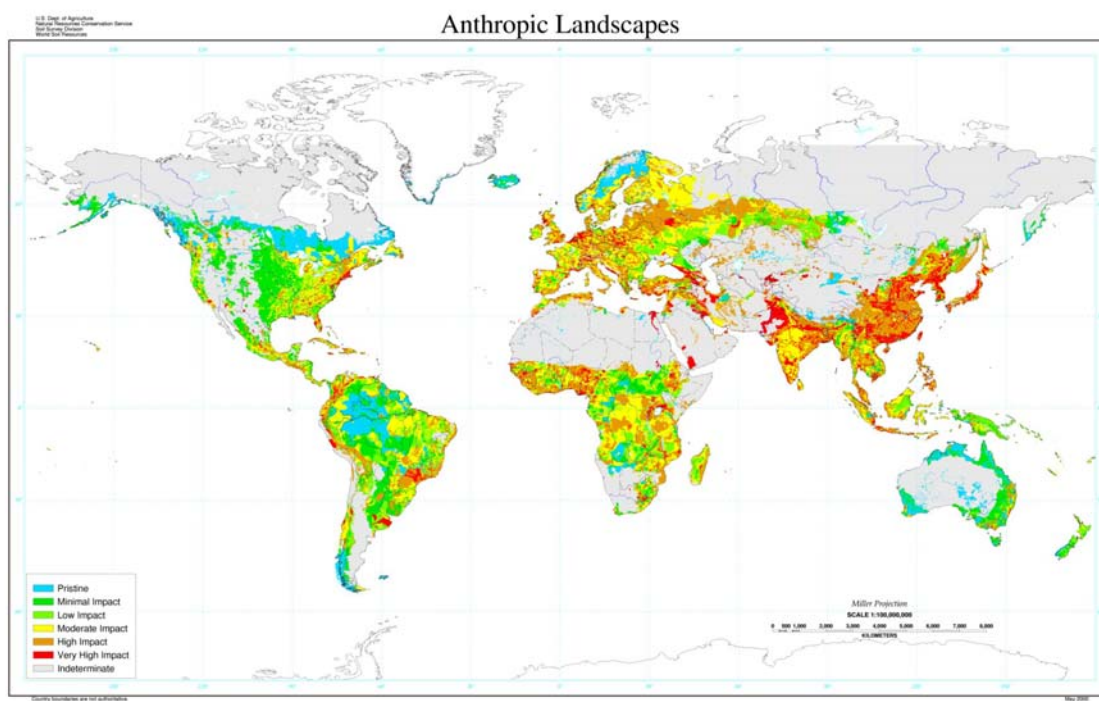
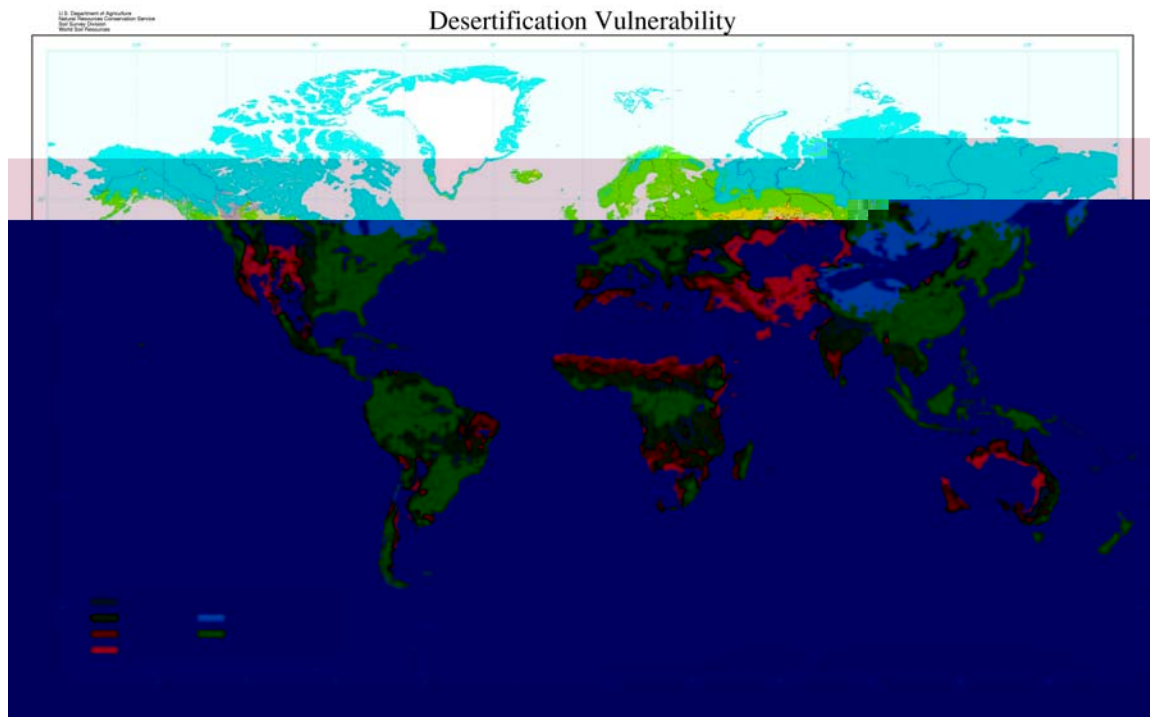
| LAND PROPERTY, STATE OR CONDITION | LAND | | POPULATION | |
|-----------------------------------|---------------------------------|------|------------|---|
| | AREA (million km ²) | % | MILLIONS | % |
| 10. CARBON STOCKS | | | | |
| Soil Carbon | Peta grams | | | |
| Soil Organic Carbon (SOC) | 1,526 | 100 | | |
| Arctic (Permafrost) | 387 | 25.4 | | |
| Arid | 145 | 9.5 | | |
| Mediterranean | 40 | 2.6 | | |
| Semi-arid | 337 | 22.1 | | |
| Humid | 535 | 35.1 | | |
| Perhumid | 83 | 5.4 | | |
| Soil Inorganic Carbon (SIC) | 940 | 100 | | |
| Arctic (Permafrost) | 18 | 1.9 | | |
| Arid | 732 | 77.8 | | |
| Mediterranean | 50 | 5.4 | | |
| Semi-arid | 134 | 14.2 | | |
| Humid | 4 | 0.5 | | |
| Perhumid | 2 | 0.2 | | |
| Soil Carbon (Ecological Regions) | | | | |
| Soil Organic Carbon | | | | |
| Arctic | 387 | 25.4 | | |
| Boreal | 376 | 24.7 | | |
| Temperate | 355 | 23.3 | | |
| Tropical | 408 | 26.6 | | |
| Soil Inorganic Carbon | | | | |
| Arctic | 18 | 1.9 | | |
| Boreal | 256 | 27.2 | | |
| Temperate | 518 | 55.1 | | |
| Tropical | 149 | 15.9 | | |
| Soil Carbon (Forest Soils) | | | | |
| Soil Organic Carbon | 582 | 38.1 | | |
| Arctic | 277 | 18.2 | | |
| Boreal | 84 | 5.5 | | |
| Temperate | 58 | 3.8 | | |
| Tropical | 162 | 10.6 | | |
| Soil Inorganic Carbon | 210 | 22.3 | | |
| Arctic | 8 | 0.9 | | |
| Boreal | 57 | 6.1 | | |
| Temperate | 85 | 9.0 | | |
| Tropical | 59 | 6.3 | | |
| SOC in Land Quality Classes | | | | |
| I | 51.3 | 3.4 | | |
| II | 80.2 | 5.3 | | |
| III | 91.8 | 6.0 | | |
| IV | 98.7 | 6.5 | | |
| V | 210.5 | 13.8 | | |
| VI | 200.6 | 13.1 | | |
| VII | 227.4 | 14.9 | | |
| VIII | 439.2 | 28.8 | | |
| IX | 125.8 | 8.2 | | |

Table 2. GLOBAL PEDO-CLIMATIC DOMAINS (Areas in 1,000 km²; percentage values are given in the second tier of each row)

| SOIL MOISTURE REGIMES | SOIL TEMPERATURE REGIMES | | | | | | | | | | | TOTAL |
|--------------------------|--------------------------|----------------------|------------|----------|------------------|-------------------|----------|----------|--------|--------|-------|-------------------|
| | Isomega- thermic | Isohyper- thermic | Isothermic | Isomesic | Mega- thermic | Hyper- thermic | Thermic | Mesic | Frigid | Cryic | Gelic | |
| Extreme Aridic | 56.80 | 331.60 | 243.90 | 109.80 | 981.10 | 8,373.00 | 2,510.40 | 1,170.00 | 270.20 | 361.90 | 5.00 | 142173REG7 ea0TAL |







Land Resource Information in Australia—Recent Activities, Future Directions

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Abstract

The Australian community and the environment are at a crossroad. After 200 years of occupation by European settlers, the country is facing a number of complex social and environmental challenges. Rural communities are in decline, there are increasing areas of degraded land (salinity, acidification, soil structure decline), and the quality of the nation's limited water resources is also declining. At the same time, there is continuing pressure to increase productivity and develop more land. In order to resolve these problems, there is a need to better match existing and future land uses to the capacity of the land and water resources. In order to reach this goal, politicians, land managers, and the scientific community need to have easily accessible information on the natural resource of the country. This paper will discuss the development of improved methods for the collection and analysis of land resource information and recent endeavors to collate existing soil data and pose some future challenges to the land resource assessment community in Australia.

Issues

The Australian landmass covers approximately 7,682,300 square km and is the flattest and driest inhabited continent. The country is generally characterized by old weathered landscapes, with depauperate soils and slow inland flowing rivers. It has a population of approximately 19.5 million people. Although this figure is relatively small, approximately 90 percent of the population lives within a 1.5-hour drive of the coastline, with the majority in large cities. Most of the population lives in the southeastern and southwestern parts of the country.

It has been estimated that approximately 40 percent of the pre-European vegetation coverage has been removed for forestry and rural development. Agricultural development has occurred over most arable land in the country. This has had a major impact on biodiversity, hydrologic processes, and soil condition and is placing a large strain on a fragile environment.

There are a number of natural resource management issues that are now facing the Australian community. Following is a brief discussion of those issues.

Salinity.—The most highly publicized natural resource hazard is the gradual salinization of some landscapes and rivers in southern Australia. Recent estimates indicate that approximately 5.6 million hectares of land are at high risk from rising shallow saline water tables. This area

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⁴ Queensland—Department of Natural Resources and Mines.

has been predicted to grow to approximately 17 million hectares by 2050 (NLWRA, 2001a). The majority of these affected areas are in the intensive cropping and grazing areas of eastern, southeastern, and southwestern Australia. It has been predicted that between 8 and 18 percent of the agricultural land in the State of Victoria has a high risk of salinity and 47 percent has a moderate risk. Salinity not only affects rural production but has also begun to impact on urban and transport infrastructure.

Water Quality.—Australia has a predominantly dry and highly variable climate. Rainfall is unevenly distributed, both spatially and temporally, and there is very little runoff (12 percent), with evaporation exceeding rainfall over the majority of the country (NLWRA, 2001b). Australia's limited water resources are in decline with an increase in salinity and nutrient levels in the inland rivers and a decrease in water quality along most coastal rivers due to the impact of agriculture and urban encroachment. Irrigated agriculture accounts for approximately 75 percent of water use in Australia (NLWRA, 2001b). It has been estimated that by 2050 the City of Adelaide's (Pop. approx. 1 million) drinking water supply from the Murray River will be below World Health Organization standards for 50 percent of the year (MDBC, 2000). Changing land use in the city of Sydney's (pop. approx. 4 million) water catchments also has the potential to impact on water quality (CSIRO Land & Water, 1999).

Soil Carbon Decline-Greenhouse Gas Estimates.—Australian soils have inherently low levels of soil carbon. It has been estimated that there is approximately 35-40 giga-tons of organic carbon in Australia's soils and that half of this amount is stored in the top 30 cm. Land clearing contributed 13 percent of Australia's total greenhouse gas emissions in 1996. Approximately 50 percent of this figure was due to release of greenhouse gases from the soil (AGO, 2001). The reduction in soil carbon has also contributed to the general decline in soil structure in the agricultural regions of Australia.

Soil Erosion.—Rates of soil erosion have dramatically increased since the arrival of Europeans. The change in hydrologic regimes following wholesale land clearing has resulted in an increase in the delivery of sediment to streams and rivers. Gully and in-channel erosion has also accelerated in the upper regions of the Great Dividing Range in the east of the continent (Eyles, 1977). Wind erosion and deposition are major features of the Australian landscape, especially in the arid interior where the vegetation cover is minimal.

Acid Sulfate Soils.—Although there are localized occurrences of acid sulfate soils (ASS) in inland Australia, most attention is currently focussed on coastal and estuarine ASS. A national survey has estimated that there are 40,000 km² of coastal ASS containing over one billion tons of sulfidic compounds. Left undisturbed, ASS are benign, but disturbance by excavation or drainage oxidizes the sulfidic compounds, producing large quantities of sulfuric acid. When fully oxidized, each ton of pyrite produces 1.6 tons of sulfuric acid (SCARM and ARMCANZ, 1999). These conditions also release high concentrations of toxic metals, especially aluminium and iron. Economic impacts are felt by agricultural and aquaculture industries. ASS impacts threaten coastal development, driven by the high value of waterfront investment, and associated infrastructure worth over \$10 billion Australia-wide. The cost of treating and rehabilitating ASS associated with urban development and infrastructure projects totals many millions of dollars.

Soil Contaminants.—Australia has a widespread incidence of land and water contamination that can lead to ecosystem and human health impacts. It has been estimated that there are over 80,000 contaminated sites in the urban and rural environments, and over \$300 million is spent annually managing or remediating contaminated land and water bodies in Australia.

Soil Acidification.—The extent of soil acidification in Australia has not been accurately defined. It has been estimated that 90 million hectares are experiencing a gradual decline in pH and of that area, 33 million hectares have a water pH that is below 4.8 (AACM International, 1995). There is a need to discriminate between those soils that are naturally acidic and those that are becoming acidic due to human activities (Williams, 2001). It should be noted that liming is not widely practiced and the cost of lime is prohibitively expensive in some districts.

Policy Responses

Decade of Landcare—1989-1999

A notable feature in natural resource management in Australia has been the Landcare movement. The formal start of Landcare had its origin in 1986 in a joint National Farmers' Federation–Australian Conservation Foundation proposal to the Commonwealth Government that highlighted the need to take action to halt the increasing level of land degradation. This proposal emphasized the importance of a self-help approach, relying heavily on local community groups, within a framework that recognised the responsibilities of the Commonwealth, State, and local governments.

Landcare is a community-based approach to fixing environmental problems and protecting the country's natural resources. During the Decade of Landcare the number of community Landcare groups grew from 200 to over 4,500. About one in three farmers is a member of a Landcare group.

The National Landcare Program, the source of government funding, also resulted from this initiative. Funding was provided for projects at the national, State, and local community scale. Most land resource assessment projects undertaken by State and Territory agencies throughout the 1990's were funded from this source.

In 1996, the Decade of Landcare and the National Landcare Program were subsumed into the Natural Heritage Trust.

Natural Heritage Trust—1996-2002

The Natural Heritage Trust takes a broader perspective than the Decade of Landcare. It focuses on five key environmental themes—land, vegetation, rivers, coasts and marine, and biodiversity. Approximately \$1.5 billion will be provided by the Federal Government for the initiative over a 6-year period (EA&AFFA, 2000).

The overall aim of the initiative is to develop sustainable agriculture and natural resource management and to protect biodiversity through improved management and delivery of resources. The “Trust” has a stronger focus on linking individual landholders and local communities with Local, State, and Commonwealth government natural resource management

objectives. Funding is provided for environmental activities at a community level, a regional level, a State/Territory level, and a national level.

National Action Plan for Salinity and Water Quality—2000

Despite the energy and investment that have been devoted to Landcare activities, many chronic problems remain, the most notable being salinity. As a response, a National Action Plan for Salinity and Water Quality (the National Action Plan) was endorsed by the Prime Minister, Premiers, and Chief Ministers at the Council of Australian Governments on 3 November 2000 (AFFA, 2000b).

The National Action Plan represents the first concerted and targeted national strategy to address salinity and water quality problems. Key objectives of the Action Plan are to:

- prevent, stabilize, and reverse trends in salinity, particularly dryland salinity affecting agricultural production, the conservation of the environment and community assets (such as houses and roads); and
- improve water quality and secure reliable water supplies for human, agricultural, and industrial uses and for the environment.

The overall distribution of funds from this initiative is still to be resolved, although a large sum of money has already been allocated to undertake a national airborne geophysical survey to identify salt stores in the regolith.

Brief History of Soil Survey in Australia

Professor J.A. Prescott was appointed the first Chief of the Council for Scientific and Industrial Research (CSIR)⁵ Division of Soils in 1927. He introduced to Australia a number of modern soil science concepts and ideas relating to soil classification. In 1931, Prescott produced the first maps showing broad soil zones for Australia (Isbell, 1992).

In 1953, C.G. Stephens formalized the Great Soil Group concept in his *Manual of Australian Soil* and in 1961 produced a map and publication titled *The Soil Landscapes of Australia* (Isbell, 1992).

In 1960, K.H. Northcote published *A Factual Key for the Recognition of Australian Soils*. This classification system was used as the framework for the Atlas of Australian Soil project (1960-68). The *Atlas of Australian Soils* (1:2,000,000) was launched at International Congress of the International Society of Soil Science, which was held in Adelaide, Australia, in 1968. Stace *et al.* also released *A Handbook of Australian Soils* at the congress. The concepts presented in this publication followed on from the Great Soil Group concepts of C.G. Stephens.

To this day, the *Atlas of Australian Soils* is the only comprehensive coverage of Australian soils. The series of maps that make up the atlas were digitized by the Bureau of Rural Sciences in 1991 and are now freely available via the Web. The *Australian Soil Resource Information*

⁵ This organisation preceded the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

System (ASRIS) will soon supercede the *Atlas of Australian Soils* for the intensive agricultural regions of Australia.

Since the 1968 congress, CSIRO has gradually shifted away from conducting land resource assessments. Much of this task has been taken up by State and Territory agencies. However, CSIRO still provides national leadership in the field of soil survey through the *Australian Collaborative Land Evaluation Program (ACLEP)* and the development of the *Australian Soil Classification* by Ray Isbell in 1996.

Standards and Communication

Australian Collaborative Land Evaluation Program (ACLEP).—In the early 1990's, the following observation was made regarding the status of soil and land survey in Australia:

There is a serious lack of reliable information on the soils and land resources of Australia. The current survey coverage is incomplete and survey data cannot be used to resolve a range of contemporary problems. Ironically, the lack of information is greatest in areas of economic importance and environmental significance. Land resource information is needed to establish sustainable use, guide management and determine the extent of degradation. A more coordinated and accelerated program of soil and land survey is essential. Improvements to methods of survey are also necessary (McKenzie, 1991).

McKenzie (1991) went on to propose the formation of ACLEP. In 1992, funding for a period of 5 years (AUD \$250,000 p.a.) was secured from CSIRO and the Commonwealth. The program has received continued short-term funding since 1997.

ACLEP is comprised of a small project team and is administered by CSIRO Land & Water. The program relies on the cooperation and in-kind support of its stakeholders in other Commonwealth, State, and Territory agencies and is loosely modeled on the U.S. National Cooperative Soil Survey, but on a much smaller scale. The program has three main objectives:

- Set national standards for all aspects of land resource assessment and land condition monitoring.
- Provide a forum for communication for those who gather and use land resource information.
- Encourage the development and application of innovative methods for land resource assessment and land condition monitoring.

Tasks undertaken by the program include:

- Coordinating the revision of the Australian Soil and Land Survey Handbook series;
- Conducting regular field and technical workshops that facilitate the development of standards and provide a forum for communication;
- Producing a quarterly newsletter for the land resource assessment community;
- Acting as the Australian point of contact for international soil and land resource assessment agencies;
- Promoting the development and use of the Australian Soil Classification;

- Funding the exchange of staff between State and Territory agencies for short periods of time (2-3 weeks) in order to facilitate the sharing of knowledge and skills;
- Sponsoring visits by international experts to Australia for the exchange of knowledge;
- Developing database protocols for the exchange of soil and land information between agencies;
- Sponsoring the Queensland Department of Natural Resources and Mines for the Enhanced Resource Assessment (ERA) program;
- Exploring innovative methods for undertaking soil and land resource assessment.

Data Collection

Soil and land resource information has been systematically collected in Australia since 1920's. CSIRO traditionally had a role in this area work, although it has gradually withdrawn from that role since the 1960's. Since that time, the role of collecting soil information has been taken up by the State and Territory agencies with varying levels of funding and activity. For the most part, they have undertaken soil-landscape mapping in the intensive agricultural areas. Mapping has generally occurred at a scale of 1:100 000 and, in some areas, at 1:50,000.

New Methods

A feature of Australian land resource survey has been the great diversity of approaches. This creates problems but also allows for innovation. Some interesting case studies are summarized below.

Bago-Maragle State Forest Soil Survey Project

This study explored the use of quantitative techniques for predicting soil properties in a forest environment (McKenzie and Ryan, 1999). The objective was to implement a quantitative analogue of conventional survey practices. The project area covered approximately 300 km² of subalpine forest in southeastern New South Wales.

Prior to the commencement of a field sampling program, various data layers were collected from various government agencies and integrated into a GIS. They included airborne radiometrics (K, U, Th), lithology, digital elevation models, Landsat MSS imagery, and climatic information. This information was used to stratify the study area based on specific combinations of attributes, namely, slope, microclimate, and lithology. A statistically based sampling strategy was then designed using the stratification.

Field sites were precisely located using differential GPS. Soil pits were excavated, and traditional soil descriptions were completed. In addition, samples were collected to undertake a comprehensive assessment of soil biological activity and the physical soil characteristics. Information obtained from the field program was combined with existing data to refine the original conceptual models and predict the likely occurrence of soil properties. This information was provided to the end-users in a Web-based decision support system.

Enhanced Resource Assessment Project

This project was initiated by the Queensland Department of Natural Resources and Mines

(QDNRM). It involves collaboration with soil scientists from other State and Commonwealth government agencies. The Enhanced Resource Assessment (ERA) project commenced in 1996 at a critical time for soil survey and land evaluation in Australia, with a general decrease in funding, loss of institutional recognition and support, and a general aging of the soil survey community. There was, however, a continuing high demand for soil and land information. It became apparent that the existing survey methodologies and systems for delivering information were inadequate to satisfy the users needs.

The main objective of the ERA project was, and still is, to improve the efficiency and effectiveness of land resource survey activities. The project leaders proposed the use of new modeling approaches, information technologies, databases, and visualisation techniques to advance the accuracy and flexibility of soil survey and land evaluation projects.

To date, the project has achieved change by applying new approaches in a series of multi-disciplinary case studies covering a range of environments and stakeholders. The project has involved the development of:

- an explicit soil-landscape modeling approach to land resource assessment supported by information technology with emphasis on prediction and accuracy;
- spatial databases as working tools throughout the life of each project to enhance survey procedures and meet initial client needs; and
- innovative ways to disseminate information, including particularly the use of visualization and presentation tools.

More information on the ERA program can be found at
<http://www.dnr.qld.gov.au/resourcenet/land/era/>.

Synthesis Studies

Murray-Darling Basin Soil Information Strategy (MDB SIS)

The Murray-Darling Basin (MDB) occupies approximately 14 percent of the Australian continent. It accounts for 71.1 percent of the total area of irrigated crops and pastures in Australia (based on 1992 estimates), approximately 70 percent of all water used for agriculture in Australia, and 41 per cent of the nation's gross value of agricultural production (1992) (MDBC, 2001). Prior to 1998, the only basin-wide coverage of soil information was the *Atlas of Australian Soil* at a scale of 1:2,000,000 (Bui, 1998).

The Murray-Darling Basin Soil Information Strategy was a collaborative project between the Murray-Darling Basin Commission (MDBC); CSIRO Land and Water (managing agency); the Commonwealth Bureau of Rural Sciences (BRS); NSW Department of Land and Water Conservation; Victorian Department of Natural Resources and Environment; Primary Industries SA; SA Department for Transport, Urban Planning and the Arts; and Queensland Department of Primary Industries.

The project entailed the collation and digitizing of existing soil, soil landscape, and land systems maps from all participating agencies, along with information from associated published reports. Other information integrated into the project included geology (1:250,000

scale), Landsat MSS images, the 9-second digital elevation model for Australia, and digital topographic data.

In areas where soil maps did not exist, soil distribution was estimated by creating rule-based models that integrated geology, Landsat MSS data, and digital terrain models as well as soil information from neighboring areas. The assumption underlying the development of these models is that soil distribution reflects the long-term interaction between terrain variables, geology, and vegetation in landscapes and that the existing soil maps have captured those interactions. The rule-based models were created using a variety of data-driven and knowledge-driven approaches (Bui, 1998). Some products from the project included:

- A soil attribute database that collated all existing soil data for the MDB;
- A terrain relief map of the MDB;
- A unified, seamless lithology map of the MDB;
- A unified, seamless soil-landforms coverage of the MDB at a nominal scale of 1:250,000;
- Interpreted data layers for soil hydraulic conductivity, texture, pH, nutrient status, and solum thickness;
- A graphical interactive computer-based analysis tool that facilitates implementation of environmental modeling scenarios using various combinations of data layers.

For more information on the MDB SIS, go to
http://www.affa.gov.au/docs/rural_science/mdbsis/index.html.

National Land and Water Resources Audit (NLWRA)—Australian Soil Resources Information System (ASRIS)

The National Land and Water Resources Audit (NLWRA) is a program of the Natural Heritage Trust and was established with the aim of providing a comprehensive national appraisal of Australia's natural resource base. The "Audit" is focused on seven themes, including:

1. Water Availability;
2. Dryland Salinity;
3. Vegetation Management;
4. Rangeland Monitoring;
5. Agricultural Productivity & Sustainability;
6. Capacity for Change; and
7. Ecosystem Health.

The creation of the Australian Soil Resources Information System (ASRIS) is a major output of Theme 5. The ASRIS project has engaged land resource assessment agencies across Australia in a \$1.4 million project to develop the information system. The ACLEP network has facilitated the exchange of information between agencies. The information derived from the project will be used for the prediction of land degradation impacts and for modeling agricultural system sustainability and productivity.

ASRIS will replace the Atlas of Australian Soils for the more intensively used agricultural zone of Australia and will include spatial estimates of soil properties. The soil properties include permeability, available water capacity, pH, soil nutrient status, percentage clay, soil

texture, bulk density, erodibility, structural stability, solum depth, and thickness of A and B horizons. A statement of reliability and certainty will be attached to estimates of each attribute to reflect the source of the information and the nature of the analyses (and necessary assumptions) that were required to derive its value.

The soil attribute information contained within the system will be used as an input to many other resource assessment components of the Audit. The soil information system will deliver the following products:

- A national database that collates existing point measurements of soil attributes;
- A soil-type map stored in a geographic information system (GIS);
- A relief map based on a 9" (250 m) digital elevation model and associated environmental attributes;
- A surface lithology map derived from geological and regolith mapping;
- Spatial estimates of soil attributes and their uncertainty at 250-m resolution.

Gaps in the spatial coverage will be filled using geo-statistical models that incorporate climatic, terrain, and geological information with the knowledge of soil distribution from adjacent mapped areas. This methodology is similar to those developed in the MDB SIS project. Information products from the project will be made freely available over the Web. For more information on ASRIS, go to: <http://www.nlwra.gov.au/>.

Future Directions

The Australian community is searching for solutions to a number of natural resource management issues. The land resource assessment community can play a vital role in providing these solutions, but the focus of their work and the information they deliver have to be relevant to the rest of society. No longer can soil information be collected only to satisfy the needs of agricultural production or academic curiosity.

The land resource assessment community can play a key role in servicing the needs of the Landcare movement, but the information delivered to these users needs to be detailed enough to apply at the farm or small catchment scale. At the same time, information needs to be in a form that can easily be integrated and generalized to assist in solving natural resource management problems at a regional or national scale. Information needs to be packaged in a way that is useful to all these users and needs to be presented in a way that is readily accessible (i.e., Web-based information).

There is a need to consider the properties and function of soils in whole-of-landscape systems. Soils play a vital role in determining the quantity and quality of water delivered to rivers and ground-water systems as well as the viability of vegetation communities. More information is required on the movement of water, sediments, and nutrients through landscapes. This in turn will determine the viability of urban and rural communities and agricultural production systems and maintenance of both terrestrial and aquatic ecological systems.

Improved information is required on the capacity of soils to dispose of contaminants and to act as a filter for domestic water. Information on the potential agricultural productivity of soils is needed. There is currently great pressure to increase the size of urban areas, often at the

expense of the most productive soils in the area. Information is also required on the location of naturally occurring contaminants that may impact on the health of human and livestock communities.

The relationships established by the ACLEP initiative need to be continued. This mechanism can be refined to provide a more concerted voice to all levels of government on land resource assessment issues. It is also the only way that the land resource assessment community can collectively respond to the requests of government and society. Land resource assessment practitioners need to be more quantitative in the way they record information. With the advent of differential GPS, there is no excuse for not knowing the precise location at which soil information is collected. With this spatial precision there is also a need to be more quantitative in the way soil properties are measured. There is a need to move from traditional subjective descriptive methods of soil survey to taking quantitative measurements of the properties being observed. The use of remotely sensed satellite imagery, airborne-derived geophysical information, and digital terrain information should become routine practice in land resource assessment.

Finally, there is a need to collect more detailed soil information in Australia. Although the recent ASRIS project has brought together soil information at a national scale, there are still major gaps in the knowledge and understanding of our soil resources. It is quite unlikely that the soil information requirements of an individual farmer or the Warrenbayne-Boho Landcare Group, for example, could be satisfied by the information presented in ASRIS.

References

1. AACM international (1995) 'Social and Economic Feasibility of Ameliorating Acidification: A National Review'. Land and Water Resources Corporation, Canberra, Australia. P. 46
2. Australian Collaborative Land Evaluation Program (ACLEP) <http://www.cbr.clw.csiro.au/aclep/index.htm>
3. Australian Greenhouse Office (AGO) (2001) 'Greenhouse Sinks and Sustainable Land Management' http://www.greenhouse.gov.au/pubs/factsheets/fs_vegetation.html
4. Bui, E.N. (Ed) (1988) 'A soil information strategy for the Murray-Darling Basin Commission (MDB SIS)' Final Report to Murray-Darling Basin Commission <http://www.brs.gov.au/mdbsis/finalreport.pdf>
5. Commonwealth Department of Agriculture, Fisheries and Forestry (AFFA) (2000a) 'The Decade of Landcare Plan - National Overview' <http://www.affa.gov.au:80/docs/nrm/landcare/pub/dolp1.html>
6. Commonwealth Department of Agriculture, Fisheries and Forestry (AFFA) (2000b) 'National Action Plan for Salinity and Water Quality' <http://www.affa.gov.au/docs/nrm/actionplan/action-plan-index.html>
7. CSIRO Land & Water (1999) 'Audit of the Hydrological Catchments of Sydney Managed by the Sydney Catchment Authority—Final report to the Minister for the Environment, NSW State Government' Unpublished report.
8. Environment Australia (EA) and Agriculture, Fisheries and Forestry Australia (AFFA) (2000) 'Natural Heritage Trust - *Helping Communities Helping Australia*' <http://www.nht.gov.au/>
9. Eyles, R.J. (1977) 'Changes in Drainage Networks since 1820, Southern Tablelands, N.S.W.' Australian Geographer, Vol. 13. pp. 377-386.
10. Isbell, R.F. (1992) A Brief History of National Soil Classification in Australia since the 1920's' Australian Journal of Soil Research, Vol. 30 pp.825-42.
11. McKenzie, N.J. (1991) 'A Strategy for Coordinating Soil Survey and Land Evaluation in Australia' CSIRO Division of Soils. Divisional Report No. 114
12. Murray-Darling Basin Commission (MDBC) (2001) 'Murray-Darling Basin - Basin Statistics' http://www.mdbc.gov.au/naturalresources/basin_stats/statistics.htm

13. National Land and Water Resources Audit (NLWRA) (2001a) 'Dryland Salinity in Australia' A summary of the National Land and Water Resources Audit's Australian Dryland Salinity Assessment 2000. www.nlwra.gov.au/atlas
14. National Land and Water Resources Audit (NLWRA) (2001b) 'Water Resources in Australia' A summary of the National Land and Water Resources Audit's Australian Water Resources Assessment 2000. www.nlwra.gov.au/atlas
15. Northcote, K.H. (1960) 'A factual key for the recognition of Australian soils' CSIRO Australia, Division of Soils, Divisional Report No. 4/60.
16. Standing Committee on Agriculture and Resource Management (SCARM) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (1999) 'National Strategy for the Management of Coastal Acid Sulfate Soils' http://www.affa.gov.au/docs/operating_environment/armcanz/pubsinfo/ass/ass.html
17. Stace, H.C.T., Hubble, G.D., Brewer, R., Northcote, K.H., Sleeman, J.R., Mulcahy, M.J. and Hallsworth, E.G. (1968) 'A Handbook of Australian Soils'. Rellim Technical Publications: Glenside, South Australia.
18. Williams, J (2001) 'Farming without harming – can we do it?' Agricultural Science. Vol. 14 No. 1, 2001.

Applications of Soil Survey to Soil Carbon Sequestration and Global Climate Change

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ABSTRACT

Soil carbon sequestration is an important strategy to enhance soil quality and reduce the rate of enrichment of atmospheric CO₂. This manuscript describes an application of soil survey to assess the national soil carbon pool for principal soils and predominant land uses in different ecoregions of the USA. The data from on-farm experiments have shown a large potential of soil carbon sequestration in agricultural and forest soils. Commodification of soil carbon, through voluntary trading, requires a credible database on rates of its sequestration. There is also a strong need to establish the relationship between soil quality, biomass productivity and environment moderating capacity, and the soil organic carbon pool. The database can be developed through the state-level infrastructure of the Natural Resources Conservation Service (NRCS). Benchmark sampling sites can be established on principal soils within Major Land Resource Areas (MLRAs) for predominant land uses. Soil C pool is to be measured to a 1-meter depth for natural ecosystems and for improved and conventional practices of managed ecosystems. The database thus established will be used to assess: (i) the rate of soil carbon sequestration by change in land use or management, (ii) relation between soil C pool and temperature/moisture regimes, (iii) inter-relation among soil properties, and (iv) impact on soil quality. Assessing the rates of C sequestration in relation to soil quality is an important application of soil survey to environmental issues.

INTRODUCTION

The science of soil survey and classification dates back to at least 4000 years ago, when Yu, a Chinese engineer, developed a system of soil classification based on color and structure (Thorp, 1936, 1938). This was a simple system of soil classification designed to meet the simple objective of using soil as a medium for crop production. With changes in human demands and soil functions over the millennia, the objectives of soil survey and classification have also changed. With the rapid increase in population during the 20th century, from 1.65 billion in 1900 to 6.0 billion in 2000, the demands on global soil resources have also changed in terms of diverse soil functions, land uses, and the intensity of specific land uses (e.g., arable land use). Consequently, there has been a major change in soil functions of interest to humans (table 1). In addition to biomass production for food and industrial raw material, environmental moderation is an important soil function, especially with regard to degrading pollutants, improving water quality, and using soil sink capacity to sequester carbon and reduce the risks of accelerated greenhouse effect. The significance of using soil's repository capacity to sequester carbon and reduce atmospheric enrichment of CO₂ cannot be over-emphasized (IPCC, 2000; Lal, 2001).

The adverse effects of the loss of soil organic matter on the soil's ability to perform its functions were recognized even during the early decades of the 20th century. Albrecht (1938) stated that "soil organic matter is one of our most important national resources; its unwise

exploitation has been devastating; and it must be given its proper rank in any conservation policy as one of the major factors affecting the level of crop production in the future.” In accord with these observations, Nikiforoff (1938) also reported that soil productivity, its capacity to produce green plants, depends on the quality and quantity of soil organic carbon (SOC). With increasing focus on environmental quality, especially in relation to the accelerated greenhouse effect, the role of soil as a moderator of the global C cycle has become an important soil function during the 21st century.

SOILS AND THE GREENHOUSE EFFECT

Soils are an integral and vital part of the environment. They are in dynamic equilibrium with the pedosphere (or the geologic material) beneath, atmosphere above, biosphere within and above, and hydrosphere above and within or beneath through several interacting processes (e.g., photosynthesis, respiration, evapotranspiration, leaching, runoff, and deep percolation). Soils moderate the biogeochemical cycles of major elements (e.g., C, N, P, and S) and H₂O. It is the effect of anthropogenic perturbation on soil's C pool and the global C cycle that is intimately linked to the so-called “greenhouse effect.” Jenny (1980) observed that “among the causes held responsible for the CO₂ enrichment, highest ranks are accorded to the continuing burning of fossil fuels and the cutting of forests. The contributions of soil organic matter appear underestimated. Probably more CO₂ would become oxidized from debris, roots and humus for a number of years after cutting or clearing than would be released promptly by fire and immediate decay.”

Our knowledge about the importance of soils in the global C cycle has improved since Jenny's observations in 1980. The principal global C pools include oceanic (38,000 Pg or billion metric tons), geologic (5,000 Pg), soil (2,300 Pg to a 1-m depth) comprising 1,550 Pg of SOC and 750 Pg of soil inorganic carbon (SIC), atmospheric (760 Pg), and biotic (620 Pg) (Schlesinger, 1997). The atmospheric C pool has increased steadily from 280 ppmv in the pre-industrial era (around 1850) to 365 ppmv in 2000 and is currently increasing at the rate of 1.8 ppmv, 0.5 percent/yr or 3.4 Pg C/yr (IPCC, 1995, 2000). Enrichment of the atmospheric C pool has occurred at the expense of the geologic pool (due to fossil fuel combustion at the rate of 6.5 ± 0.5 Pg C/yr), the biotic pool (due to tropical deforestation and wildfires at 2 ± 1 Pg C/yr), and the soil pool (due to cultivation, mineralization, and erosion). From 1850 to 1998, 270 ± 30 Pg C were emitted from fossil fuel combustion and cement production, of which 176 ± 10 Pg C accumulated in the atmosphere (IPCC, 2000). During the same period, 136 ± 55 Pg C were emitted due to land use change, a considerable part of which may be due to the emissions caused by decomposition of soil organic matter (Lal, 2001). The historic loss of soil C pool, due to anthropogenic activities, is estimated at 3 to 5 Pg from soils of the U.S. (Lal et al., 1998) and 66 to 90 Pg from those of the world (Lal, 1999). To date, therefore, world soils have been a major source of atmospheric enrichment of CO₂. Emission of soil C to the atmosphere is accentuated by several agricultural practices (e.g., drainage, plowing, biomass removal or burning, and subsistence or low-input agriculture) and processes (e.g., erosion, leaching, nutrient depletion, and mineralization). Soil degradation by erosion and other processes exacerbates the emission of C from soil to the atmosphere. Therefore, reversal of these degradative trends can enhance the soil C pool, improve soil quality, and sequester C within the biotic and pedologic pools. Adoption of a wide range of land use and soil management

practices can lead to restoration of degraded ecosystems and soil C sequestration (Lal et al., 1999; Lal, 1999, 2001).

SOILS AND THE GLOBAL CARBON CYCLE PROGRAM

The program "Soils and the Global C Cycle" (SGCC) is an inter-institutional association comprised of The Ohio State University, NRCS, and ARS. The SGCC is housed within the College of Food, Agricultural and Environmental Sciences of The Ohio State University (OSU) and is coordinated by R. Lal, J.M. Kimble, and R.F. Follett, of the OSU, NRCS, and ARS, respectively. The program is based and built upon a long history of partnership since 1990 among OSU, NRCS, ARS, and other institutions. The SGCC works in close collaboration with similar programs and fellow institutions in the U.S. and internationally.

The mission of the SGCC is "to understand processes that govern C dynamics in soil within natural and managed ecosystems, and to identify land use and management systems that enhance soil C content, decrease soil erosion and degradation, increase soil quality, improve water quality, decrease flux of trace gases, and minimize the risks of the greenhouse effect."

The overall goals of the SGCC program are to study the dynamics of soil organic and inorganic carbon pools and fluxes for principal ecoregions and to assess the impact of anthropogenic activities on these pools and fluxes.

Specific objectives of the SGCC program are to:

1. Collate and synthesize available information on the impact of land use and land cover change on soil C dynamics and the global C cycle;
2. Evaluate baseline soil C pools (organic and inorganic) on regional, national, and global scales;
3. Assess the impacts of anthropogenic activities (e.g., land use, farming systems, urbanization, and mining) on the historic loss of soil C;
4. Quantify the impact of soil degradative and restorative processes on C pools and fluxes in natural and managed ecosystems;
5. Identify land use and management systems that enhance the soil C content in the pedosphere;
6. Develop and standardize methods for determining soil C pools and fluxes;
7. Assess the economic and societal value of soil C;
8. Identify policy issues that will lead to reductions in greenhouse gas (CO₂, N₂O, and CH₄) emissions;
9. Create public awareness about the potential and opportunities for using the soil sink for C sequestration to mitigate the greenhouse effect; and
10. Develop better linkages between physical/social scientists and policy/decision-makers.

The SGCC program has studied soil carbon dynamics in several ecosystems. However, specific emphasis has been given to: (i) cropland, grazing land, and forestry land uses, (ii) organic soils and wetlands, (iii) tundra alpine and boreal soils, (iv) tropical rainforests and savannahs, (v) arid and semi-arid lands, and (v) degraded and desertified lands.

The SGCC has been able to establish a network involving scientists from national and international organizations. Members of this network involve scientists from the following organizations: (i) The Ohio State University, (ii) U.S. Department of Agriculture (NRCS, ARS, FS, ERS, and CSREES), (iii) U.S. Environmental Protection Agency (USEPA), (iv) National Aeronautics and Space Administration (NASA), (v) Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, (vi) International Union of Soil Scientists, (vii) Global Change in Terrestrial Ecosystems, (viii) Consultative Group in International Agricultural Research, (ix) national research institutions (EMBRAPA-Brazil, ICAR-India, Food and Agriculture-Canada, CSIRO-Australia), and (x) non-governmental organizations (NGOs).

Specific researchable topics addressed by the SGCC include the following:

1. Soil erosion/deposition and C dynamics.
2. Importance of soil aggregation in C sequestration.
3. Dynamics of SIC and secondary carbonates.
4. Impact of land restoration on soil quality and C sequestration.
5. Role of residue quality (C:N ratio, lignin content) and management and conservation tillage on the soil C pool and fluxes from it.
6. Total value (farmer and societal) of soil C.
7. Land use and total system C pools.
8. Soil fertility management, precision farming, and soil water management.
9. Residue quality (C:N ratio, lignin content) effects on soil C pool.
10. Ancillary benefits of soil C sequestration.

Specific output of the SGCC include the following:

1. Workshops and conferences: The SGCC group organized three international conferences and six regional/thematic workshops. Proceedings of these conferences/workshops have been published as 15 separate volumes and constitute global literature on the topic (see list at the end of the references).
2. Public awareness: Activities of the SGCC group have created public awareness about the importance of soil C sequestration as a win-win strategy. Members of the SGCC were lead authors of the IPCC special report on Land Use, Land Use Change and Forestry (IPCC, 2000), have organized six congressional briefings over 3 years (1998 to 2001), and have presented testimony at three Senate Committee hearings. Consequently, soil C sequestration is on scientific and political agenda both nationally and internationally. Further, the option of soil C sequestration is at par with other options (e.g., forestry, industrial scrubbing, and deep injection into geological strata and oceans). An important output of this program is that soil carbon is now a recognized farm commodity that can be traded like any other commodity (e.g., corn, soybeans, milk, and meat). However, commodification of C as a farm product depends on developing a strong, credible, and easily accessible database on the rate of C sequestration in principal soils for a wide range of land uses and soil/crop management practices.
3. Training opportunities: The SGCC program has also provided training opportunities to several postdoctoral researchers and graduate students.
4. Soil C sequestration potential: The SGCC group has identified land use and

soil/crop/vegetation management practices that lead to soil C enhancement and has estimated the rate of C sequestration (table 2), which is generally higher in humid and cold ecoregions than in dry and warm ecoregions. The SGCC group has also assessed the potential of U.S. cropland, grazing land, and forest land for soil C sequestration (table 3). The total potential of U.S. agricultural and forest soils is 145 to 393 million metric tons of C (MMTC) per year with a mean value of 270 ± 175 MMTC/yr. At a modest price of \$50/MT, the economic value of soil C sequestration is \$7 to \$20 billion per annum. Further, this sequestration is about 40 percent of the C emission reductions under the Kyoto commitment.

ROLE OF SOIL SURVEY IN CARBON SEQUESTRATION

There is a close inter-dependence between soil and the environment (Olson, 1983). Further, soil survey and mapping have an important role to play in commodification of soil carbon through establishment of the rates of soil C sequestration. Development of an effective trading mechanism depends on a strong and credible database regarding the rate and sink capacity of soil C sequestration. Most of the available research information is from long-term experiments conducted on research farms. Some of these experiments were not initially designed for the purpose of soil C sequestration. It is appropriate, therefore, to quantify the rate of soil C sequestration under real-world situations on the basis of the following concepts:

- Measure soil C balance under on-farm conditions for a wide range of land use and management systems;
- Assess soil C pool to at least a 1-meter depth;
- Develop empirical relations between soil quality, biomass productivity, and SOC content;
- Establish pedotransfer functions relating SOC content to other soil properties (e.g., bulk density, available water capacity, aggregation, clay content, and CEC);
- Relate SOC dynamics to quality of crop residue input;
- Measure SIC content and formation of secondary carbonates in soils of arid and semi-arid regions;
- Establish relation between SOC and the formation of secondary carbonates; and
- Assess the significance of erosion and deposition on soil C dynamics.

If soil samples were to be obtained nationally along transects covering a broad range of soil moisture (aridic to perudic) and temperature (pergelic/cryic to isohyperthermic) regimes, the data would be useful to establish the inter-relation between the SOC pool on the one hand and climatic factors (e.g., rainfall and temperature) on the other. Thus, benchmark sites must be selected along rainfall and temperature gradients, or from Alaska to Hawaii and Maine to Arizona. Benchmark sites may be selected on the basis of Major Land Resource Areas (MLRAs) or according to one or two predominant soil series within each State. Selection of benchmark sites needs to be made to achieve the following objectives:

- Establish relationship between SOC pool and the temperature (ambient and soil) regime;
- Establish relationship between SOC pool and the moisture regime (precipitation, soil-water balance, evapotranspiration);
- Develop relation between clay content and SOC pool for similar moisture and temperature regimes; and

- Measure turnover rates (decomposition constant) in relation to soil moisture and temperature regimes.

The overall objective is to develop a matrix containing information on the SOC (and pedogenic carbonates) sequestration rate for principal soils and predominant land uses and soil/vegetation management systems. An example of the matrix to be prepared on SOC sequestration is shown in table 4. The matrix for SOC sequestration rates is to be obtained in consideration of the following:

- (a) Baseline: The baseline is to be established by measuring the SOC pool in natural ecosystems (e.g., forest, grasslands, wetlands, etc.).
- (b) Land Use and Land Use Change: The effect of land use and land use change on the SOC pool is to be measured for predominant land uses of the region. These would include arable, pastoral, and silvicultural uses and any combination of uses (e.g., agropastoral, silvipastoral, agroforestry, etc.) in the region.
- (c) Ethnic Practices: The SOC pool and rate of its change are also to be measured for ethnic and cultural groups within the MLRA or an ecoregion. These may include Amish farms, resource-poor farmers, Native American farms, etc.
- (d) Chronosequence: The rate of change in SOC/SIC pools through land use/management change is to be established by selecting chronosequences (a given practice used for a different duration, such as 5, 10, or 20 years) within a soil type. The chronosequence may be selected for the following practices: (i) conservation tillage, (ii) cover cropping, (iii) manuring, (iv) rotations, (v) irrigation, (vi) Conservation Reserve Program (CRP), (vii) Wetland Reserve Program (WRP), (viii) riparian zones and conservation buffers, (ix) burning, and (x) grazing.
- (e) Restoration of Degraded Soils and Ecosystems: Restoration of degraded soils is an important strategy for soil C sequestration, enhancing soil quality and improving the environment. In accord with the matrix outlined in table 4, there is also a strong need to establish a database for rates of soil carbon sequestration through restoration of degraded soils (table 5). The principal soil degradative processes to be selected include soil erosion (wind and water), salt-affected soils, pollution/contamination, and mine-land disturbance.

MODUS OPERANDI

The Program Coordinator is to be advised by a Steering Committee comprised of soil scientists, agronomists, statisticians, data managers and modelers, and specialists in GIS. The graduate training is an important component of the program. The program organization may involve four functional units.

- Program coordination can be contracted to an organization with ongoing projects and a track record in this topic. Sampling protocol, analytical procedures, modeling, and graduate training can be coordinated through this unit.
- Selection of benchmark sites within each MLRA can be done on the basis of predominant land uses (e.g., cropland, grazing land, forest land, or wetland). Graduate students can be assigned within each of these land uses.
- Data storage and processing are centrally located, and the data will be accessible for model validation.

- Prior to implementing it nationally, the pilot project may be initiated in one or two MLRAs to fine-tune the methodology.
- The project may be completed within 5 years (by 2007).

CONCLUSIONS

There is a strong need for establishing a credible database on soil C sequestration for major soils and predominant land uses in the principal ecoregions of the U.S. Such a database can be established through developing a program within NRCS. Site selection, soil sampling and analytical procedures, and data analyses are to be done through a standard protocol. Such a program, to be established on a long-term basis, will also provide an opportunity for graduate training. The database thus established will be important to developing and validating models. The program will serve as a role model for other countries.

REFERENCES

Albrecht, W.A. 1938. Loss of soil organic matter and its restoration. In "Soils and Men," Yearbook of Agriculture, USDA, Washington, D.C.: 347-376.

7. Lal, R., J.M. Kimble, R.F. Follett and C.V. Cole. 1998. Potential of U.S. Cropland to Sequester C and Mitigate the Greenhouse Effect. Ann Arbor Press, Chelsea, MI, 128pp.
8. Lal, R., J.M. Kimble and B.A. Stewart (eds) 2000. Pedogenic Carbonates and Global Change. CRC/Lewis Publishers, Boca Raton, FL, 378pp.
9. Lal, R., J.M. Kimble and B.A. Stewart (eds) 2000. Global Climate Change and Tropical Ecosystems. CRC Publishers, Boca Raton, FL, 438pp.
10. Lal, R., J.M. Kimble and B.A. Stewart (eds) 1999. Global Climate Change and Cold Ecoregions. CRC Publishers, Boca Raton, FL, 265pp.
11. Kimble, J.M., R. Lal and R.F. Follett (eds) 2000. Assessment Methods for Soil Carbon. CRC Press, Boca Raton, FL, 676pp.
12. Follett, R.F., J.M. Kimble and R. Lal (eds) 2000. The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect. CRC Press, Boca Raton, FL, 442pp.
13. Lal, R. (ed) 2001. Soil Carbon Sequestration and the Greenhouse Effect. SSSA Special Publ. 57, Madison, WI, 236pp.
14. Kimble, J., R. Lal and R.F. Follett (eds) 2001. Agricultural Policies and Practices for Carbon Sequestration in Soils. CRC Press, Boca Raton, FL (in press).
15. Kimble, J., R. Lal, R. Birdsey and L. Heath (eds) 2002. The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect. CRC Press, Boca Raton, FL (in press).

Table 1.—Soil functions of interest to humans.

| Traditional soil functions | Soil functions for the 21 st century |
|--|---|
| <ul style="list-style-type: none"> • Medium for plant growth • Repository of gene pool • Engineering foundation • Industrial raw material • Archive of planetary history • Repository of human history | <ul style="list-style-type: none"> • Maximizing long-term productivity • Minimizing environmental pollution • Medium for waste disposal • Filter of contaminants from water • Moderator for biogeochemical cycles • Sink for atmospheric carbon |

Table 2.—Rates of soil C sequestration for recommended agricultural practices.

| Practice | Potential rate of soil carbon sequestration (Mg/ha/yr) |
|---|--|
| Conservation tillage & mulch farming | 0.1-0.5 |
| Compost and manuring | 0.05-0.5 |
| Elimination of summer fallow | 0.05-0.4 |
| Growing winter cover crops | 0.2-0.5 |
| Integrated nutrient management/precision farming | 0.1-0.4 |
| Improved varieties and cropping systems | 0.05-0.4 |
| Water conservation and water table management | 0.05-0.3 |
| Improved pasture management | 0.05-0.3 |
| Afforestation/reforestation | 0.08-0.4 |
| Fertilizer use in forest soils | 0.8-3.0 |
| Restoration of eroded mineland and otherwise degraded soils | 0.3-1 |

Source: Lal et al. (1998); Follett et al. (2000); Birdsey (2000).

Table 3.—Total potential of U.S. agricultural soils for C sequestration.

| Strategy | Potential of soil C sequestration (MMTC/yr) |
|-------------------------------------|---|
| Land conversion and restoration | 17-39 |
| Intensification of cropland | 58-170 |
| Improved management of grazing land | 22-98 |
| Improved management of forest soils | 48-86 |
| Total | 145-393 (270 \pm 175) |

Source: Lal et al. (1998); Follett et al. (2000); Birdsey (2000).

Table 4.—Matrix of SOC sequestration rates for representative land use and management scenarios.

| MLRA | Soil Type | Cropland | | | | | | Grazing land | | | Forest soils | | | Wetlands | | |
|---------------------|-----------|----------|----|---|---|---|----|--------------|----|----|--------------|----|---|----------|----|-----|
| | | CT | CC | M | R | I | ES | CRP | IP | CG | PF | CC | F | WRP | WR | WTM |
| I II | A | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | |
| | C | | | | | | | | | | | | | | | |
| | A | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | |
| | C | | | | | | | | | | | | | | | |

CT = conservation tillage

CRP = Conservation Reserve Program

PF = plantation forestry

WRP = Wetland Reserve Program

CC = cover cropping

IP = improved pasture

CC = clear cut

WR = water recycling

M = manuring

CG = controlled grazing

F = fertilizer

WTM = water table management

R = rotation

I = irrigation

ES = ethnic system

Table 5.—Soil carbon sequestration and quality enhancement through restoration of degraded soils.

| Degradation process | Reclamation alternative | | | |
|----------------------------------|-------------------------|----|-----|----|
| | I | II | III | IV |
| I. Soil erosion | | | | |
| (i) gully erosion | | | | |
| (ii) inter-rill and rill erosion | | | | |
| (iii) wind erosion | | | | |
| (iv) sand dunes | | | | |
| II. Salt-affected soils | | | | |
| (i) saline soils | | | | |
| (ii) sodic soils | | | | |
| III. Mineland soils | | | | |
| IV. Contaminated/polluted soils | | | | |

Carbon Sequestration Under the Conservation Reserve Program in Historic Grassland Soils of the United States of America

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ABSTRACT

Future emissions of CO₂ to the atmosphere are expected to continue to increase and, along with other “greenhouse gases,” contribute to the potential for global climate warming. Capture of atmospheric CO₂-C by photosynthesis and its subsequent sequestration in soil is likely the best long-term option for C storage in terrestrial ecosystems. Adverse impacts of ongoing soil erosion in the USA resulted in legislative authority to implement the Conservation Reserve Program (CRP). The CRP returns cultivated land to permanent plant cover and that potentially increases the atmospheric CO₂-C captured through photosynthesis and its storage as soil organic C (SOC). This study evaluates that potential. Sampling sites were selected across three soil temperature and three soil moisture regimes found in the “historic grasslands” region of the USA. The sites had been in the CRP for a minimum of 5 years and were paired with cropped sites that were as similar as possible. Weights of SOC and identifiable plant material (IPM) by soil layer to a depth of about 2 m were calculated using thicknesses, bulk densities, and C analysis data. Estimates of annual rates of SOC sequestration by the CRP and differences in total amounts of IPM were made by subtracting the amount measured in cropland sites from that measured under their paired CRP sites. Our estimates across the 13-state region in this study are that the CRP sequesters about 570, 740, and 910kg SOC ha⁻¹ yr⁻¹ in the 0- to 5-, 0- to 10-, and 0- to 20-cm depth increments, respectively. A significant difference of the SOC and IPM under the CRP and cropped sites was observed at only these depth increments. IPM likely precedes the introduction of and provides the C for SOC sequestration. Average amount of IPM-C under the CRP was 2990, 3470, and 3930kg C ha⁻¹ greater than under the cropped sites. Total amounts of SOC sequestered by the CRP for the entire 5.6 million ha of land under the CRP within the soil temperature (T) × soil moisture (M) regimes included in this 13-state region are estimated as 3.19, 4.15, and 5.14 million metric tons of C (MMTC) yr⁻¹ within the 0- to 5-, 0- to 10-, and 0- to 20-cm depth increments, respectively.

Soil Management Concepts and Carbon Sequestration in Cropland Soils

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ABSTRACT

One of the most important terrestrial pools for carbon (c) storage and exchange with atmospheric CO₂ is soil organic carbon (SOC). Following the advent of large-scale cultivation, this long-term balance was disrupted and increased amounts of entering the soil exceed that lost to the atmosphere by oxidation, SOC increases. Such an increase can result from practices that include improved: (1) tillage management and cropping systems, (2) management to increase amount of land cover, and (3) efficient use of production inputs, e.g. nutrients and water. Among the most important contributors is conservation tillage (i.e., no-till, ridge-till, and mulch-tillage) whereby higher levels of residue cover are maintained than for conventional-tillage. Gains in amount of land area under conservation tillage between 1989 and 1998 are encouraging because of their contributions to soil and water conservation and for their potential to sequester SOC. Other important contributors are crop residue and biomass management and fallow reduction. Collectively, tillage management and cropping systems in the U.S. are estimated to have the potential to sequester 30-150 million metric tons of carbon (MMTC) yr⁻¹. Two important examples of management strategies whereby land cover is increased include crop rotations with winter cover crops and the conservation reserve program (CRP). Such practices enhance SOC sequestration by increasing the amount and time during which the land is covered by growing plants. Crop rotations, winter cover crops, and the CRP combined have that potential to sequester 14-29 MMTC yr⁻¹. Biomass production is increased by efficient use of production inputs. Optimum fertility levels and water availability in soils can directly affect quantity of crop residues produced for return to the soil and for SOC sequestration. Nutrients input and supplemental irrigation are estimated to have the potential to sequester 11-30 MMTC yr⁻¹. In the future, it is important to acquire an improved understanding of the SOC sequestration process. Quantitative estimates of rates of SOC resulting from practices and cropping systems, increased land cover, and efficient use of nutrient and water inputs are examples of where such information is necessary. Published by Elsevier Science B.V.

Keywords: Conservation tillage; Residue management; Carbon; Soil organic carbon; C-sequestration; Soil fertility; Energy use; C-emissions from agriculture

Wet Soil Monitoring

Wayne Hudnall, Louisiana State University

Wet Soils Monitoring projects were patterned after ICOMAC (International Committee on Aquic Soils, chaired by Johan Bouma). Projects were established in 1988 to provide data (information) for a 2-week study tour by the committee prior to the 1990 SSSA meetings in San Antonio, Texas. Ten sites each in Louisiana and Texas were selected to represent a number of expressions of wet soils. The sites were monitored under a common protocol. Funding was provided by the NRCS to NCSS Cooperators at LSU (Wayne Hudnall) and TAMU (Larry Wilding), with research by graduate students.

The success of the ICOMAC projects led to the establishment of similar projects with other NCSS cooperators, including the following:

- ✓ Oregon State University, Herb Huddleston
- ✓ University of Alaska, Chien-Lu Ping
- ✓ North Dakota State University, Jim Richardson
- ✓ Purdue University, Don Franzmeier
- ✓ University of Minnesota, Jay Bell
- ✓ New Hampshire, Steve Hundley
- ✓ Utah State University, Janis Boettinger
- ✓ University of Kentucky, A.D. Karathanasis
- ✓ NRCS in Kansas.

A minimum data set was collected at each monitoring site. Researchers were also encouraged to innovate/improve instrumentation, means of data collection, and representation of data and information. Collection of data from catenas was strongly encouraged. One emphasis was to document sites in terms of hydric soil indicators and, to the extent reasonable, wetland hydrology and vegetation. At each monitoring site (ICOMAC and Wet Soils), a pedon, representative of the soil, was described and sampled for characterization analyses by the NRCS Soil Survey Laboratory.

Nearly all of the research was conducted through graduate student theses. More than 94 publications/presentations (oral and poster) have been made. The principal researchers have met together in:

- ✓ Baton Rouge, LA, 1992. Wayne Hudnall, host
- ✓ Fargo, ND, 1994, Jim Richardson, host
- ✓ Corvallis, OR, 1997, Herb Huddleston, host
- ✓ Indianapolis, IN, 1999, Don Franzmeier, host

Members of the National Technical Committee on Hydric Soils participated in the meetings. The meetings included reports on recent research, display of posters, presentations/discussion of relevant topics, and, most importantly, visits to monitoring sites in the field for observation and discussion.

We will meet in August 2001 at Bedford, NH, Steve Hundley host. The major endeavor will be to decide on joint publications of findings, including a database of monitoring data.

State and Transition Ecosystem Models—Application to Soil Survey and Dynamic Soil Properties Databases

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State and transition models. Arid and semiarid rangelands are hypothesized to function as nonequilibrium systems (Westoby et al. 1989). Models that capture these nonequilibrium dynamics at the site (groups of similar soil map units; *sensu*, Shiflet 1973) level are called **state and transition models (STMs)**. Although the application of STMs is at an early stage, relatively large gains in understanding rangeland function are being realized by implementing this new approach. Developing an information system to manage this knowledge will require the reinterpretation of existing data and new observations and experiments within a precisely defined structure if we are to make progress in providing better quality information for land management decisions.

Plant communities that can potentially exist on a given site can be organized into multiple **states**, distinguishable from other states by relatively large differences in abiotic and biotic processes (Stringham et al., 2001). Currently, state indicators are based on vegetation (i.e., plant functional groups), but dynamic soil properties or more subtle differences in soil/plant interactions, such as spatial or temporal patterning, may differentiate states. The shifts between states are referred to as **transitions**. Transitions represent changes in the types or magnitude of ecological processes that control the movement of energy and nutrients within the community. In most cases, transitions are initiated by a particular combination(s) of management and climate. **Thresholds** are the boundary between reversible and irreversible transitions and correspond to state boundaries. State and transition models, then, are graphical and textual representations of hypotheses about the causes of persistent changes in soils and vegetation at the ecological site level and should offer testable predictions as well as guidance in how to achieve, or avoid, change.

La Copita case study. Through the literature, we examined the changes in soil properties that have occurred as a result of changes in vegetation on a sandy loam upland in the shrublands of south Texas. The research was conducted on the Texas Agricultural Experiment Station, La Copita Research Area in Jim Wells County, 15 km SW of Alice, TX (27° 40'N; 98° 12'W; elevation 80 m) in the eastern Rio Grande Plains of the Tamaulipan Biotic Province (MLRA 83c). The climate is subtropical with warm winters and hot summers. Mean annual temperature is 22.4 °C with a growing season of 289 days. Mean annual precipitation (720 mm) is highly variable (C.V.=35 percent).

Uplands in the area, which have been grazed by cattle since the late 1800s, are savanna

parklands consisting of discrete clusters of woody plants organized beneath *Prosopis glandulosa* (honey mesquite). Intercluster spaces are dominated by perennial grasses, primarily *Chloris cucullata* (windmill grass). See Archer et al. (1988) for details on plant community structure and successional patterns. The long-term interaction of heavy livestock grazing, reduced fire frequency, and increased seed dispersal by domestic stock has resulted in a shift from grassland to woody plant dominance over the past 75-100 years. See Archer et al. (1988) for a complete description.

Soils of the uplands at La Copita are mapped Rungee fine sandy loam, 1 to 3 percent slopes (USDA, 1979) and are in the Sandy Loam 83c-Central Rio Grande Plain ecological site. The convex sandy loam uplands support discrete clusters and herbaceous zones that are associated with soils having a well-developed argillic horizon (Typic Argiustolls); whereas groves occur on inclusions with minimally developed Bt horizons (Typic Ustochrepts) (Archer, 1995). Soils on the clay loam lowlands are Pachic Argiustolls and are in a different ecological site. Conditions suggesting that vegetation changes are not a result of erosion include low topographic relief, slopes of 1 to 3 percent, little evidence of erosion in the form of rills or gullies, and no evidence of deposition in the low-lying areas (Archer et al., 2001).

As vegetation has changed, soil properties have changed dramatically as well. States and transitions can be utilized to organize the plant-soil dynamics that have occurred at La Copita. The state and transition model (figures 1 and 2) includes three plant communities in “state 1”: A—tall and mid grasses; B—mid and short grasses; and C—short grasses and annuals. Plant communities D (clusters and groves) and E (woodlands) are in “state 2.”

In this presentation we will look at clay content, bulk density, pH, carbon, and nitrogen for the herbaceous plant community, clusters, and groves within the sandy loam ecological site. Because we are interested in the soil-plant dynamics for a single ecological site, soil data for the clay loam lowlands (woodland plant community) are not shown. Data and simulated values show that soil properties vary among and within states. Nutrient redistribution associated with the replacement of grasses by shrubs has resulted in the formation of “fertility islands” (Virgina, 1986; Hibbard et al., 2001). These changes in the vertical and horizontal spatial distribution of soil constituents can greatly constrain the options of managers. Soil data for plant community C may be critical to the identification of threshold values.

Where the soils are Typic Argiustolls and the plant community is clusters, these data (table 1) show significantly lower values for bulk density and significantly higher values for carbon and nitrogen in the shrub-invaded grasslands of plant community D (state 2) as compared to the short grasses of transitional plant community C (state 1). The 1.4 percent soil organic matter content under the groves of plant community D is not significantly different from the content under the short grasses or the clusters. The different soil, Typic Ustochrepts, might explain this lack of difference.

Table 1. —Soil properties, 0-10 cm (Hibbard et al., 2001).

| Soil properties | Typic Argiustolls | | Typic Ustochrepts |
|--------------------------------------|--------------------|-------------------|-----------------------|
| | C Short grasses | D Clusters | D Groves |
| Clay (%) | 20 ± 0.7^a | 20 ± 1.0^a | 18 ± 0.7^a |
| Bulk density (g/cm ³) | 1.4 ± 0.01^a | 1.1 ± 0.04^b | 1.1 ± 0.03^b |
| pH | 6.7 ± 0.2^a | 6.8 ± 0.2^a | 5.8 ± 0.2^b |
| Carbon (%) | 0.84 ± 0.05^a | 2.2 ± 0.23^b | $1.4 \pm 0.2^{a,b}$ |
| Nitrogen (%) | 0.07 ± 0.00^a | 0.18 ± 0.02^b | $0.12 \pm 0.01^{a,b}$ |

Notes: Means (1 SE) within a row followed by different letters were significantly different (n = 12).

Current herbaceous production reported at La Copita is less than 2,700 kg/ha (about the same as lbs/ac) for the short perennial grasses and annual forbs (Vega, 1991; Hibbard, 1995). The potential production of mid to tall perennial grasses is 5,000-6,000 kg/ha (USDA, 1979). Hibbard (1995) simulated the changes in soil organic carbon (0-20 cm) for the sandy loam uplands (figure 3). The decline in soil organic carbon corresponds to the onset of heavy continuous grazing and the exclusion of fire and shows that the management regime and disturbances affect soil properties. We have derived a soil organic carbon content of 1.2 percent in 1750 for plant community A (tall and mid grasses) from this simulation for comparison with today's 0.84 percent SOC content for plant community C.

Importance of dynamic soil properties. Changes in soil properties can affect the capacity of the soil to function. Increased availability of dynamic soil property information will allow the development of additional management tools to support sustainable management based on consideration of soil functions and the resistance and resilience of the soil to disturbances.

The drivers of change that can affect plant and soil properties may include natural disturbances, such as fire, drought, floods, insects, or disease, or management induced disturbances, such as absence of fire, catastrophic fire, long-term heavy grazing, invasive plants, erosion, or compaction. The interaction of natural and management-induced disturbances may cause changes when individual disturbances might not prompt a change. Changes in vegetation, and hence in soil organic matter, can result in a change in other measurable soil properties, including aggregate stability, infiltration, surface crusts, water-holding capacity, bulk density, nutrients, and pH. Because these properties have an effect on nutrient and water availability and resistance to erosion, they also affect production. Production in turn affects the bioass available for conversion to soil organic matter. This "plant biomass-soil property-plant biomass

feedback loop” illustrates the importance of understanding the drivers of change and the degree and rate of change in dynamic soil properties for the management of rangelands.

Some soil properties change very little and others change a great deal in response to disturbances. Those that are relatively static over periods of hundreds of years or more together with those that are dynamic determine the capacity of the soil to function. These functions include: (1) sustaining biological activity, diversity, and productivity; (2) regulating and partitioning water and solute flow; (3) filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic material, including industrial and municipal by-products and atmospheric deposition; (4) storing and cycling nutrients and other elements within the earth’s biosphere; and (5) providing support for socioeconomic structures and protection for archaeological treasures associated with human habitation (Karlen et al., 1997).

The importance of change in a soil property is reflected in the various ways in which that property affects the capacity of the soil to function. For example, soil organic matter is a dynamic soil property affecting many other soil properties and is related to soil functions in several ways. Soil organic matter

- binds soil particles together into stable aggregates which increase porosity and infiltration, enhance root penetration, and reduce erosion,
- contributes to soil fertility and plant productivity by improving the soil's ability to store and supply nutrients, water, and air,
- provides habitat and food for soil organisms that transform and release nutrients,
- sequesters carbon from the atmosphere, and
- reduces soil physical crusting, thus improving seedling emergence and water infiltration.

The capacity of a soil to continue to function through a disturbance depends on the resistance of the soil to change, and the capacity of the soil to recover functional and structural integrity following a disturbance or change depends on the resilience of the soil (Seybold et al., 1999). Knowledge of resistance and resilience are important planning considerations for range management, restoration, and recovery. For example, if an increase in bulk density caused by compaction results in a decrease in porosity and infiltration, the capacity of the soil to perform one of its functions, i.e., to regulate and partition waterflow, is altered (figure 4). Information about the change in a dynamic soil property may also serve as an early warning indicator of possible future degradation by reflecting an irreversible transition. Beyond this irreversible transition, one or more of the primary ecological processes of a state must be actively restored with management inputs before there can be a return to the previous state (Stringham et al., 2001).

Uses of dynamic soil property data. Dynamic soil property data are needed in planning activities, including assessment, prediction, and monitoring. These data will provide more accurate results for soil interpretations, such as hydrologic soil group. They will enhance our ability to predict soil resistance, soil resilience, vegetation

changes, and the effects of disturbances or climate change. They will provide reference values that are important for management decisions related to maintaining soil function or to restoring soil function, and they will facilitate predictions of management outcomes, such as carbon sequestration potential. The data for the transitional plant community is particularly important because it may provide early warning information that will facilitate management intervention before a threshold is crossed.

Database framework. The National Soil Survey Information System (NASIS) currently includes soil property information for the relatively unchanging static soil properties, such as texture, and also for some important dynamic soil properties, such as soil organic matter. However, it does not distinguish the values of dynamic soil properties according to their management history, or “state.” NASIS needs to be enhanced to allow the storage of dynamic soil property data in a way that shows soil-plant-management interactions. State and tr

understanding of plant-soil dynamics and communicate them to a wide variety of audiences. Predicting the outcomes of soil-vegetation interactions is critical to implementing realistic land management strategies and operations. State and transition models have high utility for describing the effects of management and climate on soil/plant interactions and can serve as a basis for decision-making. The databases and knowledge systems that support natural resource management need to be adapted to encompass new ideas about how soils and vegetation change and respond. However, we need to remember that models are representative of what we know and may well be incomplete or just plain wrong and that even systematic observations are likely to create the impression of linear change or miss critical events. Therefore, it is important to use observations and existing literature to construct critical experiments that determine important events, patterns, and changes that will provide an accurate and understandable basis for land management decision-making.

References

- 1) Archer, S., C.J. Scifres, C.R. Bassham, and R. Maggio. 1988. Autogenic succession in subtropical savannas: rates, dynamics and processes in the conversion of a grassland to a thorn woodland. *Ecological Monographs* 58:111-127.
- 2) Archer, S. 1989. Have southern Texas savannas been converted to woodlands in recent history? *The American Naturalist* 134:545-561.
- 3) Archer, S. 1995. Tree-grass dynamics in a *Prosopis*-thorn scrub savanna parkland: reconstructing the past and predicting the future. *Ecoscience* 2:83-89.
- 4) Archer, S., T.W. Boutton, and K.A. Hibbard. 2001. Trees in grasslands: biogeochemical consequences of woody plant expansion. In: E.-D. Schulze, S.P. Harrison, M. Heimann, E.A. Holland, J. Lloyd, I.C. Prentice and D. Schimel, (eds.) *Global biogeochemical cycles in the climate system*. Academic Press, San Diego, California, USA, in press.
- 5) Hibbard, K.A. 1995. Landscape patterns of carbon and nitrogen dynamics in a subtropical savanna: observations and models. Ph.D Dissertation, Texas A&M University, College Station.
- 6) Hibbard, K.A., S. Archer, D.S. Schimel, and D.W. Valentine. 2001. Biogeochemical changes accompanying woody plant encroachment in a subtropical savanna. *Ecology* 82:1999-2011.
- 7) Karlen, D.L., M.J. Mausbach, J.W. Doran, R.G. Cline, R.F. Harris, and G.E. Schuman. 1997. Soil quality: A concept, definition, and framework for evaluation. *Soil Science Society of America Journal* 61:4-10.
- 8) Seybold, C.A., J.E. Herrick, and J.J. Brejda. 1999. Soil resilience: a fundamental component of soil quality. *Soil Science* 164: 224-234.
- 9) Shiflet, T.N. 1973. Range sites and soils in the United States. Pp 26-33 in: *Arid Shrublands: Proceedings of the Third Annual Workshop of the U.S./Australia Rangeland Panel*. D.N. Hyder (ed.) Society for Range Management, Denver CO, USA.
- 10) Stringham, T.K., W.C. Krueger, and P.L. Shaver. 2001. States, transitions and thresholds: Further refinement for rangeland applications. Special Report 1024. Agricultural Experiment Station, Oregon State University, Corvallis OR, USA. (Order copies from: Dept. of Rangeland Resources, Oregon State University, 202 Strand Hall Corvallis, OR 97331-2218), or download pdf at <http://www.ftw.nrcs.usda.gov/glti/pubs.html>
- 11) Vega, A.J. 1991. Simulating the hydrology and plant growth of south Texas rangelands. Ph.D. Dissertation, Texas A&M University, College Station.
- 12) Virginia, R.A. 1986. Soil development under legume tree canopies. *Forest Ecol. Management* 16:69-79.
- 13) Westoby, M., B. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management* 42:266-274.
- 14) USDA. 1979. Soil survey for Jim Wells County, Texas. United States Department of Agriculture/Soil Conservation Service, Washington, D.C.

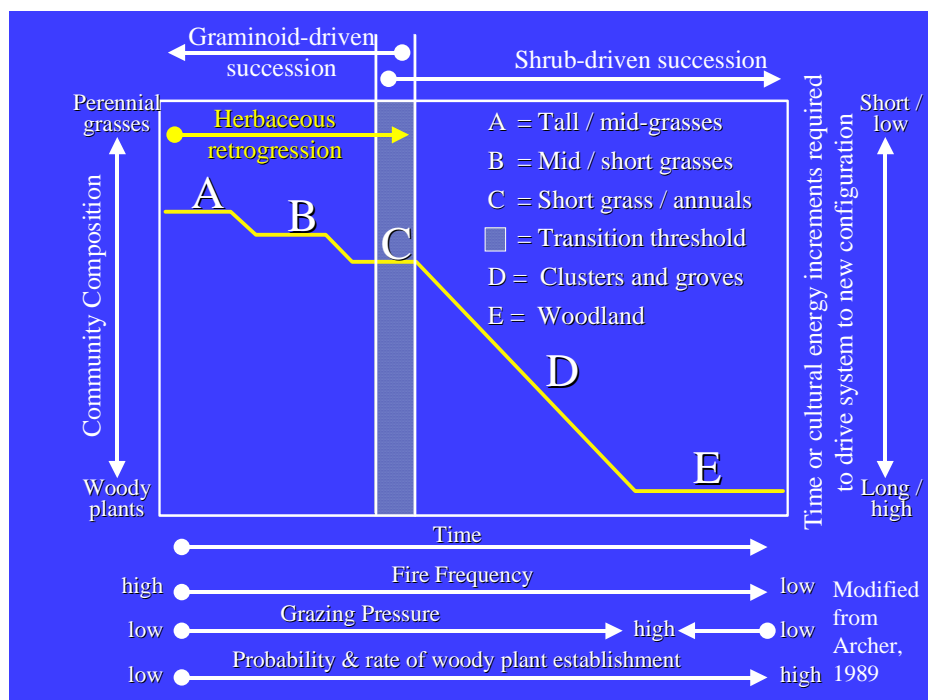


Figure 1.—State and transition model for sandy loam uplands of the La Copita study (modified from Archer, 1989),

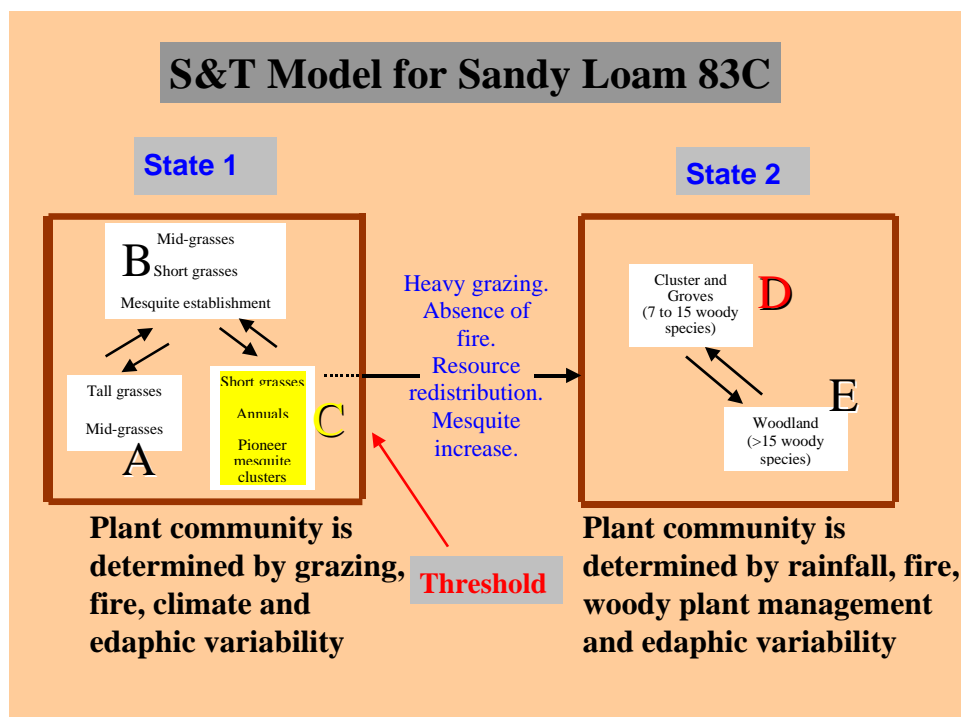


Figure 2.—State and transition model for Sandy Loam 83c in standard format for ecological site descriptions. See Stringham et al. (2001) for definitions and examples.

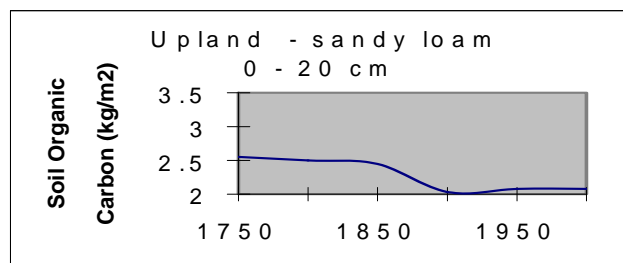


Figure 3. —Simulated soil organic carbon, 1750 to 2000
(Hibbard, 1995; redrawn from Archer et al., 2001).

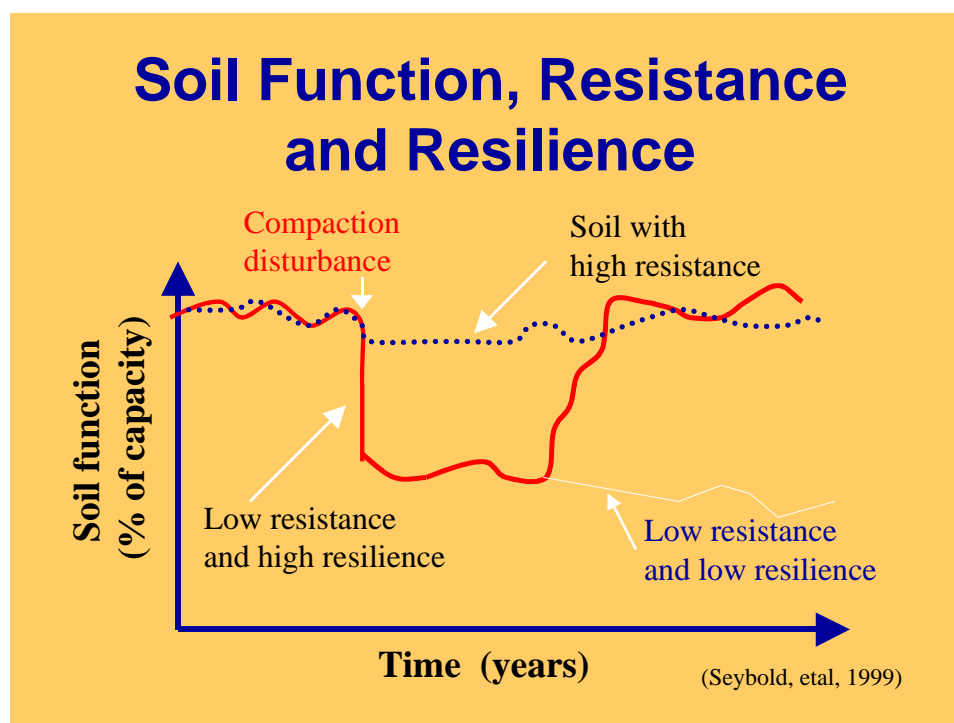


Figure 4. —Soil resistance and resilience in relation to the capacity of the soil to function (Seybold et al., 1999).

Recruitment & Examining for Soil Scientists in the Federal Government

Jason Parman, USOPM
Kansas City Service Center

Background

- OPM has helped fill soil scientist positions since August 1997.
- We currently administer a nationwide inventory for soil conservationist, soil scientist, and rangeland management specialist positions.
- OPM is involved in both policy (at the headquarters level) and product (at the service center level).

Current Issues

- Recruitment—How do you get the people you need to apply?
- Examining Process—How do you get the people that apply hired effectively?
- Hiring—How do you get the good candidates to accept employment offers?
- Workforce Planning—How can you plan for the impending "brain drain"?
- COMMUNICATION—How can you more effectively resolve issues related to recruiting and examining?

Current Flexibilities

- Many flexibilities available now that are not fully utilized—i.e., recruitment/retention bonuses, loan payments, intern programs, etc.
- HR folks know about these, but others may not—especially those who have the positions to be filled.
- Through groups such as these, flexibilities and recommendations should be advanced—committees and participants should lobby HQ for the use of the available flexibilities

What We're Doing Now

- Encouraging communication—We're putting our names and numbers out there, so if you have an issue, we can resolve it.
- Raising awareness—We're letting people know that we do indeed have soil scientist candidates who are ready to be hired.
- Solving issues and clearing up misconceptions—We can solve any problem you have...as long as we know about it.
- Improving products—We're premiering our new Dynamic Online Application in a matter of weeks.

What We Can Do

- All aspects of the recruiting, examining, and hiring processes.
- Consult on program structures and policy issues.
- Produce turnkey products, build your internal capabilities, or both.

- Serve as an enabler to get the people you need, when you need them.

What We Ask of You

- Get people involved—Tell people about what we've discussed at the conference.
- Get people talking—This is one of the most important issues you will face in the next 5-10 years, so start lobbying for additional flexibilities now.
- Let us know—Again, it is in our best interests and yours if we serve as enablers, not obstacles. Therefore, we need to know about any issues you have, so we can resolve them immediately.
- Help us help you—We can provide all aspects of HR assistance, including consulting, recruiting, and HR planning, but we need to know what your priorities and needs are.

Where You Can Go from Here

- Begin dialogues with your Human Resource staff.
- Get out to the people you will need in the near future—especially those in high school and college right now.
- Let us help—We offer a number of reimbursable services that can effectively get the right people in the right positions at the right time.
- **COMMUNICATE COMMUNICATE COMMUNICATE**

How to Reach Us

Service Centers around the country

OPM website, www.opm.gov, lists all Service Centers

Kansas City Service Center

(816) 426-5706

Kansascity@opm.gov

National Soil Information System (NASIS)—Connecting the Partnership Through the WEB & New Technology

Ken Harward & Terry Aho , ITC, NRCS & Russ Kelsea, NSSC

Fort Collins Activity

There are currently five major information systems funded for development and/or maintenance work at the Information Technology Center in Fort Collins. These systems are:

1. Program Delivery Area
 - Customer Service Toolkit (CST)
 - Soil Data Viewer (SDV)
 - Wetlands Toolkit
2. Natural Resource Data Warehouse
 - Lighthouse Project
 - Resource Data Gateway
 - Web Soil Data Viewer
3. Integrated Accountability System (IAS)
 - Performance and Results Measurement System (PRMS)
 - On-line Cost Accounting (TCAS/ACRES)
 - Workload Analysis (WLA)
 - Workforce Planning
 - RC&D Program Tracking
4. National Soil Information System (NASIS)
 - NASIS release 5.0 (central server)
 - Windows Pedon
 - Laboratory Information Management System (LIMS)
5. National Plant, Animal, and Ecological Site Information System
 - PLANTS
 - Interagency Taxonomic Information System (ITIS)
 - Ecological Site application (ESIS)
 - VegSpec

Other activities in which ITC either has a leadership role or major involvement include:

- Common Computing Environment (CCE)
- Electronic Access Infrastructure (EAI—Service Center agency Web farms)
- Telecommunications Strategy & Operation
- Data Management (standards development for Service Center agencies)
- Technical Architectures
- System Requirements and Design
- Application Programming
- Web Site Development
- Software and Hardware Testing and Certification (including CCE certification)
- Data Modeling, Data Administration
- Database Administration

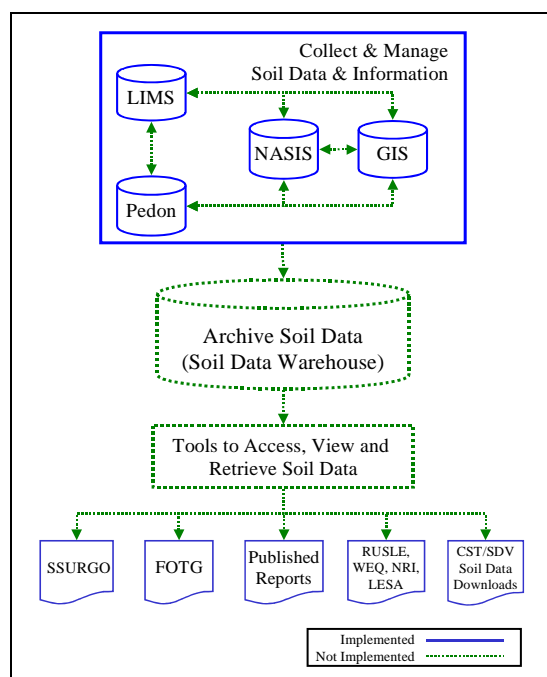
- IT Acquisition Support
- IT Implementation Support
- System Administration
- Security Operations
- Life Cycle Management
- Geographical Information Systems (GIS)
- National Help Desk

Public Distribution/NASIS

The major development in NASIS 5.0 is the Central Server. For the first time we will actually be able to share data and thus we can join survey data across MO boundaries and true statewide legends are possible. Such states as New Jersey have been waiting for this capability for a long time.

NASIS 5.0 also provides high-end tools for the delivery of technical soil services. The interpretation and report writing capabilities in NASIS can satisfy nearly any request for soil survey information. Your resource soil scientists have these tools available in NASIS today. Of course, powerful tools require skill to operate, but when resource soil scientists require powerful information management tools, these tools are available in NASIS.

Finally, a Soil Data Warehouse is under development (see diagram). Our vision is that an integrated set of information systems will feed data into a Data Warehouse. The warehouse will hold fixed versions of data and will be the sole-source distribution point of soil survey data to products, such as SSURGO, FOTG, Soil Data Viewer, and such Web-access facilities as the Lighthouse Project.



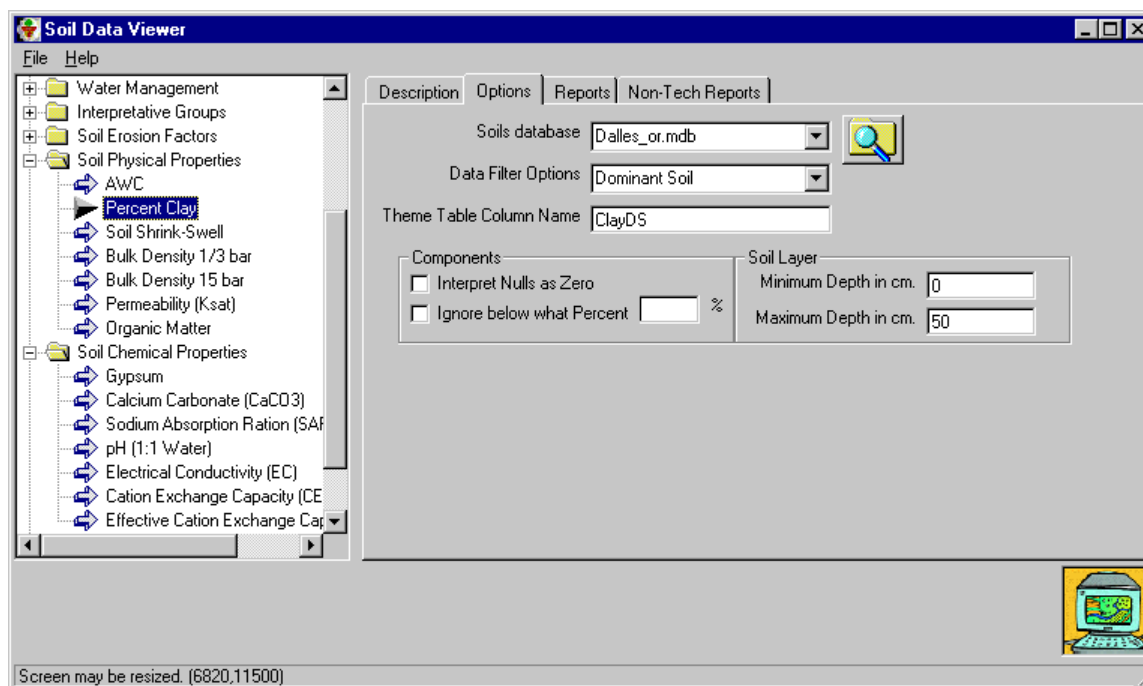
Soil Data Viewer Demonstration

This presentation shows the Microsoft Access soil database that supports the new SSURGO version 2 data structure. The MS Access soil database now contains all the classic manuscript reports that can be used for the soil reports of Section II of the FOTG. States that want to migrate from FOCS soil database before SSURGO is ready can deploy the NASIS export (imported into the MS Access soil database template) and can send the Access database to the FO for use as the major portion of Section II of the FOTG.

Soil Data Viewer version 3.0 is scheduled for release with the Customer Service Toolkit 3.0 in mid-summer 2001. SDV 3.0 is designed to work with the new SSURGO data structure. SDV 3.0 has the capability to process the MS Access soil database both in a GIS capacity (with ArcView) and a non-GIS processing of tabular reports. The current Soil Data Viewer 2.0 works only with exports created from NASIS 4.1.1. The next release Soil Data Viewer 3.0 will work only with exports created from NASIS 5.0.

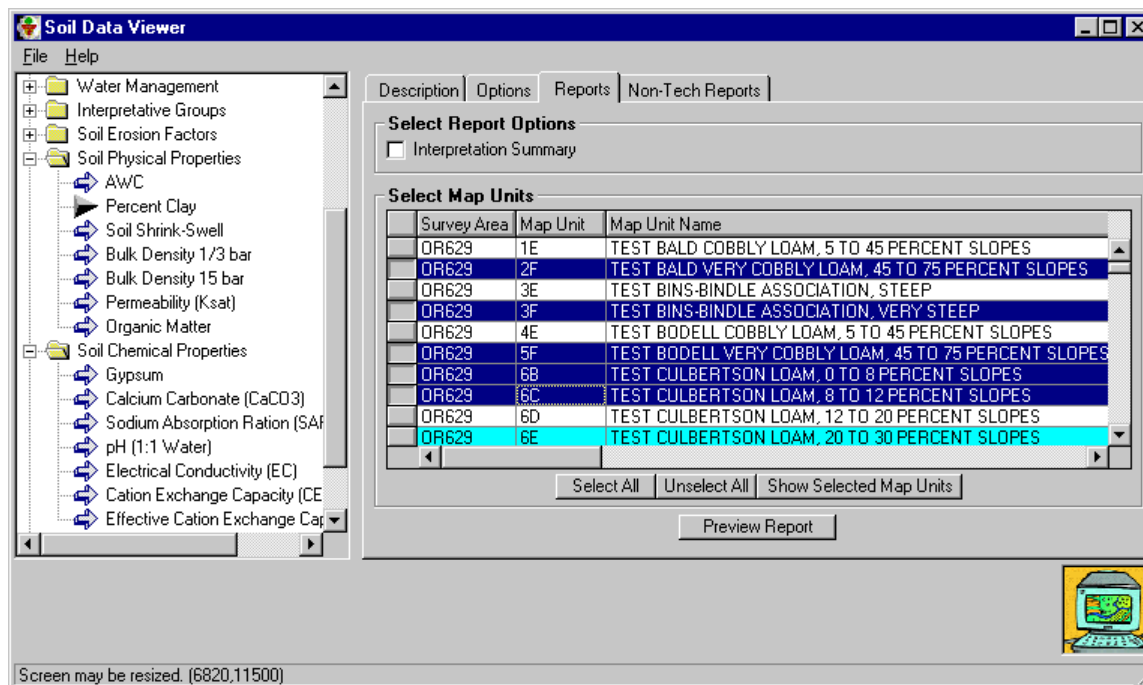
The new SSURGO data structure provides the capability to merge more than one SSURGO data set into a GIS without data conflicts. Thus, users will be able to create wide-area assessments or localized soil themes that cross the boundaries of the SSURGO soil survey.

Soil Data Viewer 3.0 has much more processing power, with the ability to process complex physical and chemical soil properties. Users can select a soil property and the depth to process that property based on the dominant soil or a weighted average.



In the previous screen, the user has selected percent clay for the dominant soil from the surface to 25 inches (50 cm).

The user can also create a tabular report for selected map units that could be included with customer map products. The user can select specific map units for reporting. In the non-GIS capacity, the tabular report can be used for processing dominant soil, dominant condition, weighted average, most limiting, and least limiting. The same processing methods are used in the GIS capacity. Thus, users at a local field office can process their soil data well before the local survey is SSURGO certified.



Soil Data Viewer 3.0 will also provide the user the ability to access nontechnical descriptions in the soil database. The nontechnical descriptions, as part of Section II of the FOTG, can be assembled for selected map units in a report that is tailored to meet the needs of the customer.

Appendix 1.—Agenda



NATIONAL COOPERATIVE SOIL SURVEY

Conference 2001

Building for the Future: Science, New
Technology & People

June 25-29, 2001
Ft. Collins, Colorado

Monday June 25, 2001

Registration - Lobby of Marriott Hotel, Fort Collins, Colorado

9:00AM–1 PM

Moderator Cameron Loerch, NRCS, Lakewood CO

General Session Salon D

1:05 PM–1:15 PM Introduction & Welcome Leroy Hall, Area
Conservationist,

NRCS, Greeley, Colorado

1:15 PM–1:35 PM Welcome to CO-- Lee Sommers, Dean, College

“Value of National Cooperative of Agriculture, Colorado State
Soil Survey Effort to the US” University

1:35 PM–1:55 PM Cooperative Efforts in Colorado, Robert Zebroski, Director,
Colorado State Soil Conservation Board

1:55PM–2:25 PM “Strategic Planning for the Science of Soil Survey in the 21st
Century” Maurice Mausbach, Deputy Chief, Soil Survey
and Resource Assessment, NRCS

2:25 PM–3:00 PM “The NCSS—Building for the Future” Horace Smith,
Director, Soil Survey Division, NRCS

3:00 PM–3:30 PM Break

3:30 PM–4:00 PM Panel—Regional Conferences Highlights &
Recommendations, NE (Tyrone Goddard (NY-NRCS), W
(Chris Smith (NRCS-HI), S (Edward Ealy (NRCS GA), NC
(Micky Ransom,(KSU)

2001 National Cooperative Soil Survey Conference

- 4:00 PM–4:45 PM** **Keynote Speaker, “*Soil Survey: Science, Technology and People*,” David Hammer, University of MO, SSSA, S-5 Past Chair**
- 4:45–5:00 PM** **Conference Logistics for Committee Meetings & Field Trip, Cameron Loerch, NRCS, CO**
- 5:30 PM–8:00 PM** **Social—Salon D and Foyer/Computer Demos & Poster Session**

Tuesday June 26, 2001

8:00 AM–10:00 AM **Committee Meetings (Open Committees. There is an opportunity to participate in 2 of the committees with an optional rotation at 9:00 AM)**

Committee 1: Selling Soil Science to Society (Salon A)

Co-Chairs: Barry Dutton & Gary Muckel

This committee should consider issues of soil survey product identification, product delivery, marketing strategies, public access to expertise, product timeliness and education on product use. **Committee 1:**

~~At 9:00 AM, David Hammer (S-5) will be in the Foyer for a presentation on the SSSA Curriculum for the 2001 National Cooperative Soil Survey Conference.~~

- 11:20 AM–11:50 AM** ***Report from New Technology Standing Committee (10 min.)***
Pete Biggam, NPS
Berman Hudson, NRCS, NSSC
(20 minute presentation of Outstanding NCSS New Technology Transfer Project selected by Committee-
The Use and Application of SoLIM in Project Soil Surveys (Sheryl Kunickis, NRCS, Washington, D.C)
- 11:50 AM–12 Noon** ***National Society of Consulting Soil Scientists –New Technology in the Private Sector***
Barry Dutton, NSCSS Past President
- 12 Noon–1:30 PM** **Lunch at Hotel (Tickets Available at Registration)**
Speaker: Terry Terrell, Research Administrator, Rocky Mountain National Park
Terry plans to present a brief overview on the park, its history prior to becoming a park, as well as background on its vast alpine ecosystem. She will also discuss local research issues, as well as aspects on information and education, and how the new soil survey can be incorporated into the interpretive program.

Moderator Jim Keys, USFS
General Session Salon D

- 1:30 PM–1:50 PM** ***USFS Highlights-Initiatives for future interagency cooperative efforts*** Jim Keys & Randy Davis, USFS, Washington, DC
- 1:50 PM–2:05 PM** ***National Park Service (NPS) Highlights***
Pete Biggam, NPS, Denver CO
- 2:05 PM–2:20 PM** ***BLM Highlights***
Bill Ypsilantis, Soil Scientist, USDI/BLM, Lakewood, CO
- 2:20 PM–2:35 PM** ***1890's Colleges Perspective—Research & Recruitment***
Richard Griffin, Prairie View A&M
- 2:35 PM–3:15 PM** ***Tribal Colleges Potential---Special Emphasis forum, Curriculum, Research & Recruitment***
Thedis Crowe, NRCS MT , Terry Tatsey, Blackfeet College, MT, and Leslie Henry, Oglala Lakota College, SD, Tribal College Representative
- 3:15 PM–3:30 PM** **Break**
- 3:30–4:00 PM** **User Perspective–Front Range Planning Issues and Concerns**
Karen Berry, Colorado Geological Survey & Jefferson Co. Soil Conservation District, Lakewood, CO
- 4:00 PM–4:05 PM** **Housekeeping reminders for Field Trip on Wednesday—**
Cameron Loerch, NRCS, CO
- 4:05–5:00 PM** ***a. In Conference Committee Meetings-Continue to complete reports (Share Salon D)***

- b. Standing Committee Meetings--Recommendations for Future Research Needs (Salon A)**
New Technology (Salon B)
NCSS Standards (Salon C)
- c. Land Capability Classification Sub-Committee**
Chair: Ray Sinclair (Salon F)

Wednesday June 27, 2001

Coffee and pastries will be available at 6:00 AM at hotel meeting site for Tour. Participants will meet Vans at 6:45 AM. Lunch will be provided with the field trip.

7:00 AM–5:00 PM Rocky Mtn Natl. Park Soil Survey: Science, Technology and People. Bobcat fire rehab activities.

Thursday June 28, 2001

7:30 AM–8:30 AM Strategic Planning for the Future of NCSS
Break Out Sessions for:
University Representatives (Salon A)
Agency Representatives (Salon D)
Private Sector and Consulting Soil Scientists

Moderator Scott Davis, BLM CO

General Session Salon D

8:30 AM–9:00 AM Special Reports--FGDC) Federal Geographic Data Committee (i.e., Terminology for geomorphic and geologic surficial materials mapping) Jim Fortner, Chair FGDC Soil Subcommittee (NRCS)

9:00 AM–10:00AM Special Reports—State and Transition Ecosystem Models—Application to Soil Survey and Dynamic Soil Properties Data Bases, Joel Brown, GLTI, NRCS, and Arlene Tugel, SQI, NRCS

10:00 AM–10:30 AM Break

10:30 AM–10:50 AM Committee #1 Report – Selling Soil Survey

10:50AM–11:10AM Committee #2 Report–Pedology Training w/Landscapes

11:10 AM–11:30 AM Committee #3 Report – Training Use & Application

11:30 AM–11:50 AM Committee #4 Report – Recruitment & Retention

11:50 AM–Noon Questions and Discussion- Action Register

Noon–1:00PM Lunch

Moderator Craig Ditzler, NSSC, NRCS

General Session Salon D

1:00 PM–1:10 PM Special Reports—SSSA & ISSS Strategy for the Future, Lee Sommers, Director, Colorado State University Ag Experiment Station, representative to the IUSS for 2006 Congress

2001 National Cooperative Soil Survey Conference

- 1:10 PM –2:00 PM** **Special Reports—Soil Carbon Sequestration and Global Climate Change—Applications to Soil Survey, Ron Follett, ARS, Rattan Lal, The Ohio State University**
- 2:00 PM–2:20 PM** **University CSIRO Land & Water, Australia, Soil Information International Perspective, Chris Malouf, Executive Officer**
- 2:20 PM–2:35 PM** **Special Reports—World Soil Resources, Hari Eswaran, USDA-NRCS**
- 2:35 PM–2:45PM** **Special Reports—Wet Soil Monitoring, Wayne Hudnall, Louisiana State University**
- 2:45 PM–3:00 PM** **Break**
- 3:00 PM–3:30 PM** **Special Reports—Recruitment & Testing for Soil Scientists in Federal Government, Jason Parman, Office of Personnel Management, Kansas City, MO**
- 3:30PM–4:30 PM** **National Soil Information System (NASIS)—Connecting the Partnership through the WEB & New Technology
Ken Harward & Terry Aho , ITC, NRCS & Russ Kelsea, NSSC**
- 4:30 PM–5:00 PM** **Panel (leadership from University, Agency and Private Sector Breakout Sessions)—Strategic Planning for the Future of NCSS, Presentations from Breakout Sessions; Review of Action Register; Where do we go from here?**
- 5 PM** **Adjourn**
- 5:00 PM–8:00 PM** **Informal Dinner at local brewery**

Friday June 29, 2001

- 8:00–AM 10:00 AM** **Submit Reports for Compilation of Proceedings**
NRCS Regional Reports
Committee Reports
Technical Speakers
Task Force Reports
- 8:00 AM–10:00 AM** **Steering Team Meeting**

Appendix 2.—Conference Recommendations to the NCSS

- 1. Invite local Area and District Conservationists to NCSS conferences.**
- 2. Include a representative from NACD to the regional and national NCSS. Have NACD become a member of NCSS.**
- 3. Need to continue to involve local boards and districts in production soil survey activities.**
- 4. Ensure that new hires are the best and brightest.**
- 5. Keep current by reading scientific articles**
- 6. Encourage professional society membership and presentation of papers.**
- 7. Make sure new technology gets out.**
- 8. Need to research new soil landscape models.**
- 9. Need better process to transfer technology, revamp NCSS forums.**
- 10. Make Soil Taxonomy relevant to a wider audience, illustrate profusely, demand it be used by other disciplines in their journals, provide taxonomic assistance to other disciplines, focus on basics.**
- 11. SSSA should accept the NCSS standards as the official professional standards.**
- 12. Need to become more involved in land use planning.**
- 13. The new paradigm of soil science should be based on temporal and spatial distribution of soil and water health and sustainability.**
- 14. Target K-12 educational opportunities.**
- 15. NCSS cooperators need to create and standardize the Knowledge, Skills, and Abilities (KSAs) needed by students in order to be hired as soil scientists by Federal agencies. This list should provide specific recommendations as to what courses and experience are needed. The list must be distributed to all university cooperators.**
- 16. Make use of available incentives, including relocation allowances, recruitment bonuses, retention bonuses, student loan repayment program, Career Intern Program, and Student Employment Programs**
- 17. Implement special pay rate for all soil scientist positions.**
- 18. Design soil surveys such that they meet the data needs of most scientists, have scale-appropriate maps, have larger scale than SSURGO, more Order 2 with windows of Order 1.**
- 19. Reactivate Soil Data Subcommittee group.**
- 20. Need a formal “official” work group to address standardizing geomorphic terms.**
- 21. Seek out and promote better relations with the tribal colleges.**
- 22. Plan for seven generations into the future.**
- 23. Expand state and transition models to other than rangeland.**
- 24. NCSS needs to embrace the private sector for cooperative efforts.**

- 25. Explore a better mechanism to bring forth and implement NCSS “policy” changes.**
- 26. Need a group email list of NCSS cooperators.**
- 27. Put wet soils monitoring information onto a CD ROM.**
- 28. Make soil surveys reliable, accessible, and relevant.**
- 29. Avoid duplication of database development.**
- 30. Make sure value is added to soil survey updates.**
- 31. Make a link between soil quality and C sequestration.**
- 32. Get Involved with 18th World Congress of Soil Science.**
- 33. Ensure that new design needs for the Soil Data Viewer and Lighthouse Project are addressed.**
- 34. The NRCS National Leader for Standards needs to follow the bylaws by routing taxonomy amendments through the regional taxonomy committees. According to the participants, this is not consistently happening.**
- 35. A higher degree of coordination is needed between the national and regional taxonomy committees.**
- 36. The NRCS leadership should appoint a permanent liaison to each of the regional conferences as required by the bylaws.**
- 37. The NRCS should take the leadership to send one of the two sets of state soil monoliths to the Smithsonian. If the Smithsonian is not interested, the Museum of Natural History in New York should be contacted.**

Appendix 3.—Steering Team Minutes

SUBJECT: NCSS Steering Committee Meeting Minutes August 24, 2001
TO: Steering Committee (see attached list) File Code: 430-14

The Steering Committee for the National Cooperative Soil Survey Conference met on June 29, 2001, at the Marriott Hotel in Fort Collins, Colorado. Members present were Horace Smith, Gene Kelly, Tyrone Goddard, Jon Hempel, Randy Davis, Bill Ysilantis, Cameron Loerch (with Steve Park), Bob Ahrens, Carolyn Olson, Jim Fortner, Russell Kelsea, Edward Ealy, Berman Hudson, Craig Ditzler, and Maxine Levin.

Horace Smith, NRCS, Soil Survey Division Director, chaired the meeting. Action items from the Conference were briefly reviewed. It was agreed that a more formal list would be submitted with a draft of the proceedings from the conference and would be tracked for action by the Steering Committee at a later time. Since there was only one representative from the Land Grant and 1890 institutions, the committee agreed to plan to meet at the Annual SSSA Meetings in October 2001, in Raleigh, North Carolina. The Committee requested that meeting be scheduled for Monday or Tuesday at about 5 to 7 P.M. to follow the S-5 Business meeting. Maxine Levin will follow up to make reservations with SSSA.

There was a request to continue Committee 1, Selling Soil Science to Society. The Committee Reports for Committees 2, 3, and 4 were accepted pending review of the proceedings of the conference. There was a request to rotate the Standing Committee Chairs every 2 years with appointments made in the even years. There were requests to add new Standing Committees to review agency policy and the purpose of conferences. Discussion was tabled until the meeting in October, which will include more university representatives.

Regional Conferences for 2002 are tentatively scheduled as follows:

| | |
|------------------------------|------------------|
| Northeast—Thousand Lakes, NY | June 24-28, 2002 |
| North-Central—Madison, WI | June 24-28, 2002 |
| South—Savannah, GA | June 3-6, 2002 |
| West—Gunnison, CO | TBA |

There were proposals for the next National NCSS Conference to be held in the Northeast in West Virginia, Maryland, and New Jersey. Carolyn Olson, NRCS Liaison to the Northeast, will contact those states in NRCS. The committee will decide at the October meeting which state could best host the conference in 2003.

The Steering Committee meeting was adjourned at 9:30 AM.

SUBJECT: NCSS Steering Committee Meeting Minutes

November 2, 2001

TO: Steering Committee

File Code: 430-14

The Steering Committee for the National Cooperative Soil Survey Conference met on Monday, October 22, 2001, 5:00 P.M. to 6:00 P.M., Ardrey Room, Hilton Charlotte & Towers, 222 E. Third St., Charlotte NC 28202. There was a forum present with representatives from Land Grant Universities, BLM, and NRCS and representatives from each of the four regions.

Horace Smith, NRCS, Soil Survey Division Director, chaired the meeting. The purpose of the meeting was to follow up on the action items proposed in the NCSS Conference in Ft. Collins in June 2001, to select a host state for the 2003 National NCSS Conference, and to identify any critical topics to be coordinated for the regional conferences in 2002.

A draft copy of the Proceedings of the 2001 NCSS Conference, in Ft. Collins, CO, was reviewed for content and format. Action items from the conference were briefly reviewed. It was agreed that many of the items were already being addressed. The committee asked that the "Action items" be called "Recommendations to the NCSS" in the final printing of the proceedings. Action item 2—membership inclusion of NACD and other similar groups, such as NASCA—was discussed. The Conservation Districts and State Conservation Agencies are active sponsors and cooperators at the local level of the NCSS in many states. They are, as a rule, not active on a national scope, and their input and participation as a rule are not technical. It was proposed and accepted that the regional conferences would make a concerted effort to invite NACD and NASCA representatives to the summer meetings. Next year, the NCSS 2003 Steering Team will consider proposals for new membership in the NCSS.

The committee reviewed the Standing Committees of the National Conference and agreed to mirror the content of those committees in the coming regional conferences to reinforce recommendations on both the national and regional levels. The Soil Taxonomy Committee plans to use the Regional Conference Taxonomy Committees as reviewers for new standards and Soil Taxonomy proposals.

The following guidelines and expectations for the 2002 regional conferences were discussed:

1. Regional Proceedings—Historical Documentation as well as information;
2. Forum for NCSS Standards, Proposals, and Discussion through Committees;
3. Forum for New Technology and Regional Technical Issues;
4. Proposal and Recommendations to the 2003 National NCSS Conference; and
5. National Conference attendees and Standing Committee Members for 2002-2004.

2001 National Cooperative Soil Survey Conference

Regional Conferences for 2002 are scheduled as follows:

| | |
|------------------------------|------------------|
| Northeast—Thousand Lakes, NY | June 24-28, 2002 |
| North-Central—Madison, WI | June 24-28, 2002 |
| South—Savannah, GA | June 3-6, 2002 |
| West—Telluride, CO | July 8-12, 2002 |

The Steering Committee accepted the nomination from the NE-NCSS region of the host and location of the next NCSS Conference 2003:

Plymouth, MA

June 16-20, 2003

Contacts—Carolyn Olson, NSSC, Lincoln, NE

Bruce Thompson, NRCS, Amherst, MA

Pete Veneman, U. of Mass, Amherst, MA

The Steering Committee meeting was adjourned at 6:00 PM.

The Steering Committee Members for this Conference are:

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2001 National Cooperative Soil Survey Conference

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Appendix 4.—Participants

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| Chris | Malouf | Mr. | CSIRO Land and Water | Canberra | Australian Capital Territory (ACT) | Australia | +61 2 6246 5951 | Chris.Malouf@cbr.clw.csiro.au | The Australian Soil Classification - An Interactive Key |
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| George | Vance | Professor | University of Wyoming | Laramie | WY | USA | 307-766-2297 | gfv@uwyo.edu | |
| Pisoot | Vijarnsorn | Dr. | Land Development Department | Chatuchak | Bangkok | Thailand | 001-66-2-561-2948 | Pisootv@ladd.go.th | |
| Carl | Wacker | Assistant State Soil Scientist | USDA, NRCS | Madison | WI | USA | 608-276-8732 ext 246 | carl.wacker@wi.usda.gov | Automation of Compilation with OrthoMapper Software |
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